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Joseph C. Greenley, Director

DWORSHAK FISHERIES STUDIES

Job Performance Report

Project DSS-29

(A Corps of Engineers sponsored, U. S. Fish and Wildlife Service administered project)

Job 2. Evaluation of Changes in Species Composition and Abundance of Game Fish Above Dworshak Reservoir

Job 3. Evaluation of Game and Rough Fish Populations Below Dworshak Dam and Relationship to Changes in Water Quality

Job 4. Evaluation of the Limnological Characteristics and Fisheries of Dworshak Reservoir

Period Covered: 1 March 1976 to 28 February 1977

by

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September, 1977

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JOB PERFORMANCE REPORT

State of Idaho Name: DWORSHAK FISHERIES STUDIES

Project No. DSS-29-7 Title: Evaluation of Changes in Species Composition and Abundance of Game Fish Above Dworshak Reservoir

Job No. 2

Period Covered: 1 March 1976 to 28 February 1977

ABSTRACT

In 1976, the number of cutthroat trout collected from North Fork Clearwater tributaries was nearly identical to 1975 and remained at a level approximately 300% greater than preimpoundment abundance.

The number of rainbow-juvenile steelhead collected from the Lochsa River tributaries increased 17% in 1976 from the previous year. A significant number of age 1 chinook salmon fingerlings were collected from Lochsa tributaries in 1976.

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INTRODUCTION

In the 1976 Job Completion Report, the initial, preimpoundment portion of the investigation and the postimpoundment segment was reviewed and summarized. This investigation began in 1969 and continued through 1975. The evaluation of the impact of Dworshak Dam and Reservoir of fish populations above the impoundment terminated in 1975, and a decision to continue monitoring species composition was made. In 1976, project personnel continued the tributary trend sampling and snorkeling (underwater observations) established transects on the North Fork of the Clearwater above Dworshak Reservoir. The following narrative and tables incorporates observations made in 1976 with trends which developed during the previous 7-year investigation.

OBJECTIVES

To continue evaluation of changes in the game fish populations of the North Fork and tributaries above Dworshak Reservoir as the reservoir ages and postimpoundment fish populations are established.

TECHNIQUES USED

Tributary Trend Samples Collected with Explosives

We continued sampling fish populations in one pool in each of eight tributary streams of the North Fork Clearwater River in late August to ascertain species composition and length frequencies. Three pools in tributaries of the Lochsa River served as controls (Fig. 1 and 2). Pool sizes and locations are described in the 1971 report (DSS-29-2). We measured the total length of all fish collected by species.

Snorkeling (Underwater Observations)

We counted the 10 established river sections (200 m) between Kelly Forks and Aquarius Campground three times during July and August 1976. Using a wet suit and snorkel, two divers made consecutive passes 5 minutes apart and we averaged the counts for each species counted.

FINDINGS

North Fork Tributary Sample Trends

In 1976, the number of rainbow collected from sample sites on the eight North Fork tributaries increased slightly from 1975 (Table 1). The number collected in 1976 remained higher than reduced samples collected immediately after the removal of steelhead from the drainage. Only two individuals collected in August 1976 were age 0 fish (Table 2).

The number of cutthroat trout collected from the North Fork tributaries in 1976 was identical to the previous year's sample in 1975. The collection made from Beaver Creek had 18 juvenile cutthroat. The next highest number

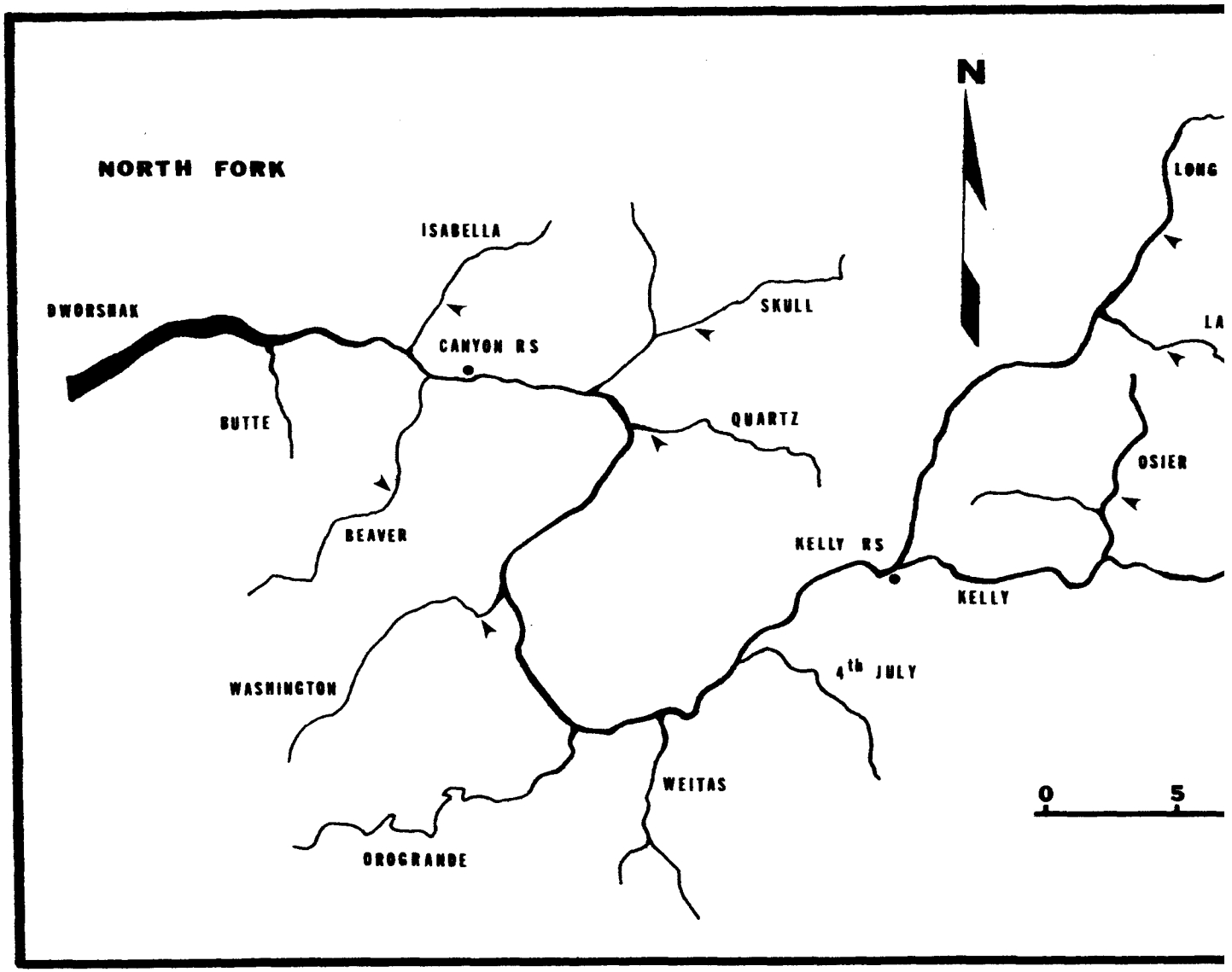

Figure 1. North Fork of the Clearwater River above Dworshak Reservoir. Arrows indicate approximate location of eight tributary sample sites.

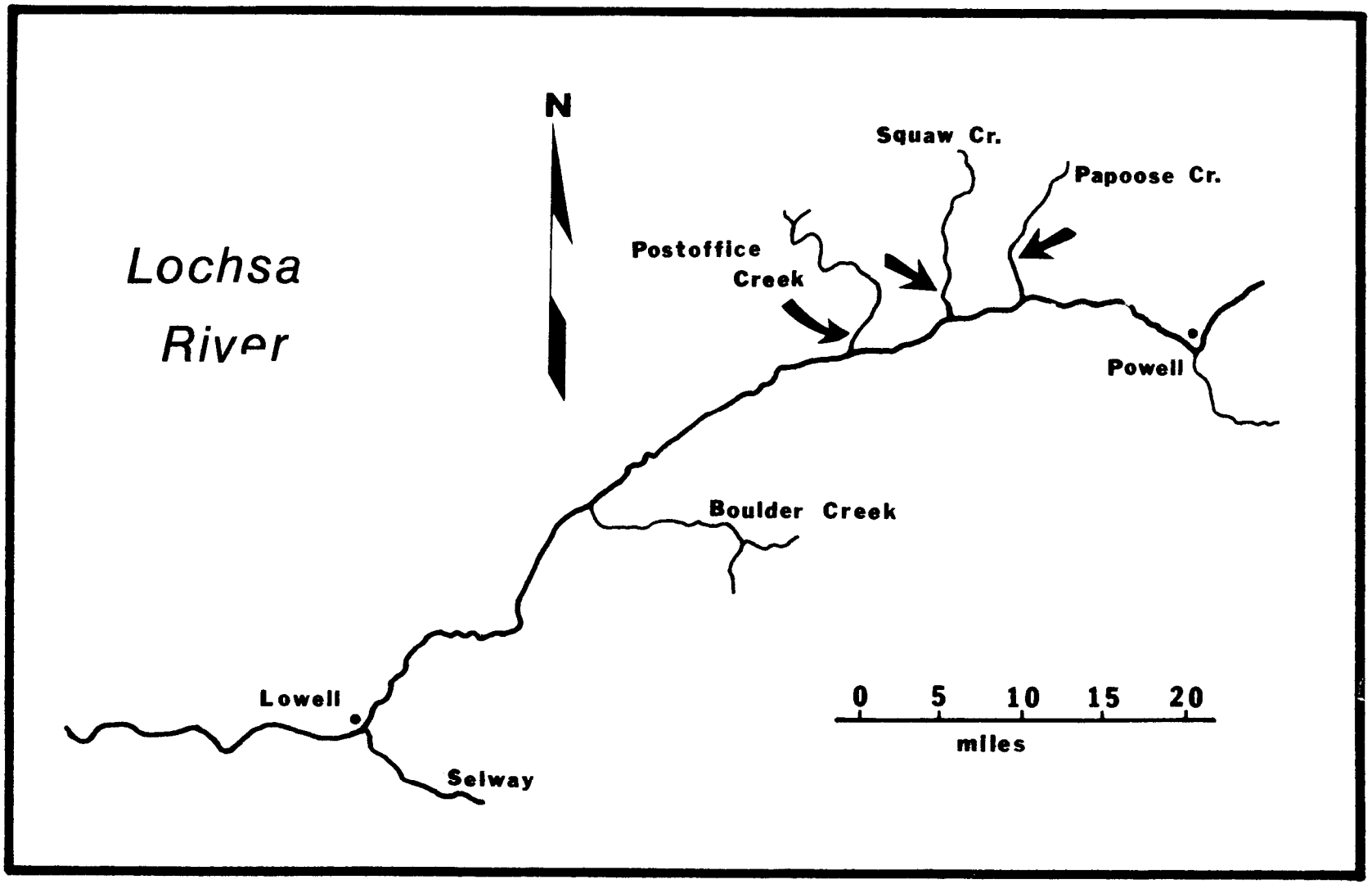

Figure 2. The Lochsa River showing the location of three tributary sample sites.

Table 1. Length frequency of rainbow-juvenile steelhead trout from North Fork of the Clearwater and Lochsa River tributaries 1969-1976.

North Fork tributaries	Total length in 10 millimeter groups																					Total
	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	230+	
1976				1				1	1	4	3	2	1	2	4	2	2	1	3			1	27
1975							1	2	1	1		3	3	3	4	3	1	1	1			1	25
1974			1	1		1	1	2	9	11	6	5	2		2	1						2	44
1973									1	5	2	4	1	2	1	1			1				20
1972										5	1				1	1	4	2			1		15
1971											3	3	5	2	6	3	8			1			29
1970							4	4	10	13	8	6	4	5	5	5	1						65
1969			1	25	11	1	2	6	15	7	15	7	9	6	7	3	4	1					120
Lochsa tributaries																							
1976		1	3		1	2	1	3	4	4	1	3	2	2		2							29
1975		1	1	1	2	2	3	2	4	5	1	2											24
1974	10	32	38	30	8	6	4	6	3	3		1					2		1	1		1	146
1973		38	31	4	1	6	3	11	5	4	2	2	2	1	3	2	1						116
1972		12	2	28	103	56	8	2	3	2		1		1		2							220
1971		69	26	1	9	10	17	4	2	2	7	6	1	1						1			156
1970		41	16	5	6	6	12	8	6	9	4	3	2				1						119
1969		11	37	20	5	4	5	5	7	3	1	2	3		1								104

Table 2. Fish collected from selected pools on tributary streams on the North Fork of the Clearwater and Lochsa Rivers during August, 1976 and totals from the previous 7 years.

North Fork tributaries	Number of each species collected in 1975											
	HRB	WRB	CT	DV	WF	SCU	CHN	BRT	SU	KOK	RSS	Totals
Beaver Creek		5	18	0	0	0			0			23
Isabella Creek		2	1	0	1	0			5		1	10
Quartz Creek		3	3	0	6	0			53		125	190
Skull Creek		5	7	1	6	0			6			25
Washington Creek		2	0	0	1	0			0			3
Osier Creek		4	10	0	3	0			1			18
Long Creek		2	8	3	1	1			0			15
Lake Creek		4	1	0	0	0			0			5
Totals 1976	0	27	48	4	18	1	0	0	65	0	126	289
Totals 1975		25	48	3	35	1			25		104	227
Totals 1974	2	42	22		43	1			27		133	270
Totals 1973		60	41	2	60	3				6	19	191
Totals 1972		15	11		30							56
Totals 1971		29	14	1	20	2		1				67
Totals 1970		65	10	4	32	8						119
Totals 1969		125	14	5	19	14						177
Lochsa tributaries												
Post Office Creek		7	1	0			0					8
Squaw Creek		7	0	1			23					31
Papoose Creek		15	8	0			4					27
Totals 1976		29	9	1			27					66
Totals 1975	2	24	2	1								29
Totals 1974	5	141	5			5						156
Totals 1973	11	117	1	2				1				132
Totals 1972	1	220	23	4		2			1			251
Totals 1971		156	40	2		1						199
Totals 1970	1	119	14	3		1						138
Totals 1969	2	105	51	1		1						160

HRB = Hatchery rainbow trout
WRB = Wild Rainbow trout
CT = Cutthroat
DV = Dolly Varden
WF = Whitefish
SCU = Sculpin
BRT = Brook trout
SU = Sucker
KOK = Kokanee
RSS = Redside shiner
CHN = Chinook

occurred in Osier Creek where 10 cutthroat were sampled (Table 1). Cutthroat abundance in the last two collections have averaged approximately three times the numbers collected in the preimpoundment years. The increased abundance due to restrictive angling regulations and adult steelhead removal should continue.

The number of rainbow-juvenile steelhead collected from the three Lochsa River tributaries increased 17% over the previous year 1975 (Table 1). The number collected still remains far below the average abundance found in samples prior to the critical declines in adult steelhead escapement occurring after 1974. Approximately 38% of the 29 rainbow-juvenile steelhead collected in 1976 were young-of-the-year.

The number of cutthroat collected from Lochsa tributaries increased 40% over the previous 3-year average in 1976. Cutthroat abundance in the upper Lochsa tributaries may increase when no-kill regulations go into effect on the main river in 1977.

The number of suckers collected in North Fork tributaries increased 62% over the previous 2-year average in 1976. Since most suckers were collected from lower river tributaries, it may be assumed that these individuals had migrated upstream from Dworshak Reservoir. The 1976 Lochsa River tributary samples included 27 age 1 chinook fingerlings. In the previous 7-year sampling, only two individuals were collected. Unspawned adult spring chinook were planted in the sample tributaries in 1972 and fry and fingerling plants took place in 1973 and 1974. The age 1 fingerlings collected in 1976 were yearlings from adult spawning in 1975.

Snorkeling Trend Counts

In 1976, three dives were made between 7 July and 3 September. On 7 July we observed an average of 5 cutthroat per diver, 17 rainbow trout, 52 mountain whitefish, 878 suckers, and 7 squawfish for 1,830 m (2,000 yd) of transects (Table 3).

On 8 August we observed an average of 2 cutthroat, 6.5 rainbow, 69 whitefish, 422 suckers and 3 squawfish per diver.

On 3 September, we counted an average of 8.5 cutthroat, 17 rainbow, 247 whitefish, 533 suckers and 45 mature kokanee.

The underwater observations made during 1976 did not differ noticeably from the previous year. Suckers continued to be the most abundanct species during the summer diving period. Apparently a small run of early spawning kokanee have become self-sustaining in the North Fork as they have been present in all observations made during September since their first spawning efforts in 1973.

LITERATURE CITED

Pettit, S. W. 1976. Evaluation of changes in species composition and abundance of game fish above Dworshak Reservoir. 1976 Completion Report, Idaho Department of Fish and Game.

Table 3. Fish numbers observed by two divers floating ten 183 m (200 yd) sections of the North Fork of the Clearwater River (Aquarius Campground to Kelly Forks) during July, August and September, 1976.

Transect No.	Diver No.	Species					
		Cutthroat			Rainbow		
		7-16	8-18	9-3	7-16	8-18	9-3
1	1	3	0	2	1	1	4
	2	1	1	2	0	0	1
2	1	0	0	1	1	2	2
	2	0	0	0	0	0	2
3	1	1	0	0	2	0	2
	2	0	0	0	0	0	1
4	1	3	1	3	9	4	5
	2	1	0	1	3	4	1
5	1	0	1	3	0	0	1
	2	0	0	1	0	0	0
6	1	0	0	0	5	1	1
	2	0	0	0	0	1	1
7	1	1	*	*	2	*	*
	2	0			1		
8	1	0	1	1	4	0	3
	2	0	0	1	1	0	2
9	1	0	0	0	3	0	1
	2	0	0	0	0	0	1
10	1	0	0	1	1	0	3
	2	0	0	1	1	0	3
Totals		10	4	17	34	13	34
Average per diver		5	2	8.5	17	6.5	17

*Too shallow to dive

Table 3. Fish numbers observed by two divers floating ten 183 m (200 yd) sections of the North Fork of the Clearwater River (Aquarius Campground to Kelly Forks) during July, August and September, 1976 (continued).

Transect No.	Diver No.	Species: Whitefish 7-16	Whitefish 8-18	Whitefish 9-3	Sucker 7-16	Sucker 8-18	Sucker 9-3
1	1	6	32	90	9	38	35
	2	0	15	83	0	30	37
2	1	11	36	25	17	78	39
	2	5	12	19	0	50	34
3	1	17	10	32	28	15	9
	2	17	9	19	31	12	5
4	1	3	1	16	55	16	43
	2	0	5	20	40	20	38
	1	5	2	9	9	6	40
	2	1	5	3	2	8	45
6	1	15	3	53	200+	19	200+
	2	9	0	35	150+	10	200+
7	1	0	*	*	200+		
	2	0	*	*	200+	*	*
8	1	5	1	19	58	14	34
	2	9	0	26	32	10	35
9	1	0	0	11	300+	55	65
	2	0	0	21	150+	13	60+
10	1	0	0	6	150	300+	97
	2	0	2	7	125	150+	90
Totals		103	138	494	1,756	844	1,106
Average per diver		52	69	247	878	422	533

*Too shallow to dive

Table 3. Fish numbers observed by two divers floating ten 183 M (200 yd) sections of the North Fork of the Clearwater River (Aquarius Campground to Kelly Forks) during July, August and September, 1976 (continued).

Transect No.	Diver No.	Species					
		Squawfish			Kokanee		
		7-16	8-18	9-3	7-16	8-18	**9-3**
1	1	0	0	0	0	0	12
	2	0	0	0	0	0	10
2	1	0	0	0	0	0	0
	2	0	0	0	0	0	0
3	1	0	0	0	0	0	0
	2	0	0	0	0	0	0
4	1	3	1	0	0	0	0
	2	0	0	0	0	0	0
5	1	0	0	0	0	0	5
	2	0	0	0	0	0	2
6	1	4	2	0	0	0	20+
	2	1	2	0	0	0	15+
7	1	5	0	0	0	0	0
	2	1	0	0	0	0	0
8	1	0	0	0	0	0	15
	2	0	0	0	0	0	12
9	1	0	0	0	0	0	0
	2	0	0	0	0	0	0
10	1	0	1	0	0	0	0
	2	0	0	0	0	0	0
Totals		14	6	0	0	0	91
Average per diver		7	3	0	0	0	45

JOB PERFORMANCE REPORT

State of Idaho Name: DWORSHAK FISHERIES STUDIES

Project No. DSS-29-7 Title: Evaluation of Game and Rough Fish Populations Below Dworshak Dam and Relationship to Changes in Water Quality

Job No. 3

Period Covered: 1 March 1976 to 28 February 1977

ABSTRACT

Cool weather during the 1976 summer and unusually warm weather in the fall provided excellent fishing conditions on the lower Clearwater River. Anglers fished an estimated 12,600 hours and harvested an estimated 650 smallmouth bass, 5,050 rainbow trout-juvenile steelhead and 208 cutthroat trout.

Cooler than normal discharge from Dworshak Dam during the summer reduced lower Clearwater River temperatures during July and August. Discharge temperatures were reduced to provide favorable water quality criteria at Dworshak National Fish Hatchery.

The trend towards oligotrophy on the lower river continued in 1976. Total alkalinity ($CaCO_3$) ranged between 14 and 28 mg/1 at the Spalding sampling site. North Fork water remained at near "distilled water" standards. Total alkalinity measured at Dworshak National Hatchery ranged between 11 and 15 mg/1.

Approximately 40% of the adult hatchery steelhead tagged and released by anglers during the 1975 steelhead season returned to Dworshak National Fish Hatchery in spring 1976. Tagged females were spawned individually and their reproductive success (eyed-egg percent) compared statistically with unplayed females. Comparison of 24 experimental pairs did not differ statistically (t-test, $P > .05$) between caught-and-released steelhead (86.5%) and control fish (86.2%)

A total of 1,858 adult steelhead were handled at Dworshak National Fish Hatchery during the 1976 spawning operation. Of the 1,726 adults sampled, 62.6% were females and 37.4% males.

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RECOMMENDATIONS

Project biologists should spend additional time with Dworshak Hatchery biologists to accurately determine the age-class composition of returning adult steelhead. Estimates based on scale analysis appear inaccurate and mark identification and length frequency distributions should provide additional information necessary for age-class determinations.

The steelhead fishery on the lower Clearwater River should continue to be monitored by project biologists after the Dworshak Fisheries Investigation ends in 1977.

Tagging studies on the effects of catch and release on adult steelhead behavior should continue in the 1976 fishery. More accurate identification methods should be used to separate wild and hatchery reared steelhead.

Efforts should be made to evaluate wild steelhead escapement and production in the upper Clearwater River drainages.. Juvenile steelhead abundance and inventory of remaining spawning and rearing habitat should have first priority.

OBJECTIVES

To monitor changes in water quality and flows of the lower Clearwater River below Dworshak Reservoir and relate these to changes in abundance and growth of game fish and nongame fish species.

To evaluate the returns of adult steelhead trout to the fishery and to Dworshak National Fish Hatchery and the impact of hatchery steelhead on the lower Clearwater River fishery.

To evaluate predictions of water quality changes, primarily temperatures, for use in evaluating predictions about other proposed dams.

TECHNIQUES USED

Angler Creel Census

We conducted a random angler creel census on the lower Clearwater River (Lewiston to Orofino) during the summer season from 23 May to 25 September.

During the summer census period, we made angler counts on both weekend days and 2 randomly selected weekdays each week; a total of 8 census days per 2-week interval. Four angler counts, two in the morning and two in the afternoon, were made each census day while driving Highway 12 between Lewiston and Orofino. Anglers were interviewed during each census trip.

We divided the lower Clearwater River (Lewiston to Orofino) into three sections: Section 1 - slack water portion of the Clearwater Arm of Lower Granite Reservoir; 2 - old Washington Water Power Dam site to Lenore bridge; and, Section 3 - Lenore to Orofino. Section 4 is the North Fork Clearwater

River below Dworshak Dam to the Ahsahka Bridge (Fig. 1).

We interviewed anglers between counts to ascertain residence, number of hours fished and number of fish caught. We examined all fish in anglers' creels for brands, fin clips, and indication of hatchery origin (dorsal erosion).

Computation of Estimates

Fishing effort in hours is the product of average angler counts (4), times the average daylight hours per day during the interval, times the number of days in the 2-week interval. Weekend days and weekdays were calculated separately. Effort was partitioned by angling type (boat vs. shore) during the steelhead season. The number of daylight hours used to calculate estimates were based on sunrise and sunset tables of the Nautical Almanac Office, U. S. Naval Observatory. The daily sunrise and sunset times were plotted graphically against dates and in each 2-week interval, the midpoint values were used to derive the average daylight length.

Water Temperatures

We recorded the water temperatures throughout the year with Moeller constant recording thermographs at Orofino (main river), McGill hole, Lenore bridge and from the North Fork below the Dam (Dworshak National Fish Hatchery). The water temperatures taken at the latter site approximate the temperature of the North Fork, but may be periodically influenced by water leaving the hatchery.

Water Quality

Water quality sampling by Department personnel was discontinued on a regular basis in 1976. Instead, more accurate water analysis reports supplied by the Idaho Department of Health and Welfare and the U. S. Fish and Wildlife Service were used to monitor river water parameter from the North Fork (Dworshak Hatchery) and main Clearwater (Spalding).

Monthly values for temperature, dissolved oxygen, pH, turbidity (JTU), alkalinity ($CaCO_3$), phosphate and nitrate are reported for both sample locations.

Steelhead Catch-and-Release Survival and Behavior

To study the survival of adult steelhead trout released by anglers during the catch-and-release fishery, numerous steelhead were caught, tagged and released. Fish were captured using conventional fly and spinning methods by project personnel and cooperating sportsmen on the Clearwater and Snake Rivers. Numbered, metal jaw tags allowed workers to record recaptured steelhead during the sports fishery as well as to identify those returning to hatchery facilities (Pettit 1976).

In a joint effort with the Cooperative Fishery Unit, 12 Dworshak Hatchery steelhead also were captured by hook-and-line in the Snake River during January and February and equipped with radio transmitters prior to release. These overwintering Dworshak Hatchery steelhead were then tracked using radio telemetry, during their spring migrations back to the hatchery.

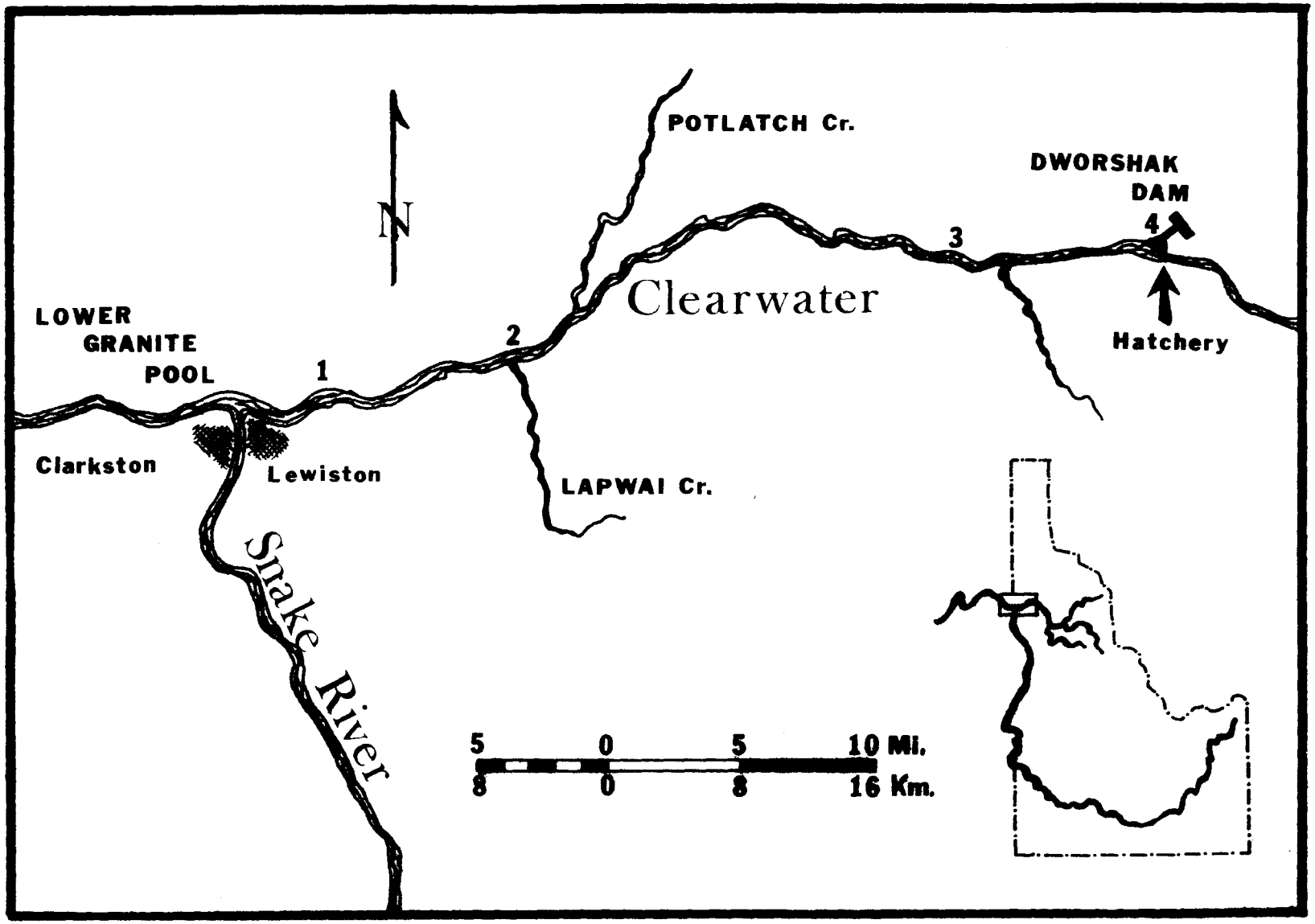

Figure 1. The lower Clearwater River from its mouth to Orofino, Idaho. Numerals indicate the four creel census areas between Lewiston and Orofino.

Caught-and-released female steelhead returning to Dworshak Hatchery were spawned individually and their reproductive success (eyed eggs) was determined. Reproductive success of both the experimental and control fishes was compared statistically with each other and with the hatchery average.

FINDINGS

Angler Effort and Estimated Harvest

Shore anglers fished an estimated 12,600 hours during the 1976 summer census period to catch an estimated 650 smallmouth bass, 5,050 trout-juvenile steelhead, 208 cutthroat trout, 173 mountain whitefish and 1,607 northern squawfish (Table 1).

As in previous investigations, no attempt was made to assess the effort and harvest by anglers fishing from boats and rafts during the summer months in 1976. The numbers of rafting and boating recreationists using the lower Clearwater has been increasing annually and a significant harvest may be taking place.

Total angler effort during the 1976 summer census period (25 May to 31 September) increased approximately 42% from that of 1975 and was the highest effort during the 8-year investigations. Anglers harvested 73% more rainbow-juvenile steelhead, 23% more smallmouth bass, and 63% more cutthroat trout than the previous year.

Water Temperatures

Mean maximum water temperatures in the North Fork of the Clearwater River during 1976 ranged from 3.6 C (38.5 F) in February, to 18.3 C (64.9 F) in August. Temperatures were recorded at Dworshak National Fishery Hatchery in Ahsahka, Idaho. Mean maximum temperatures in the Clearwater River at Orofino ranged from 0.4 C (32.7 F) in February to 23.9 C (75.0 F) in August. Mean weekly temperatures recorded at the North Fork and main Clearwater above the confluence were generally cooler during the early summer and significantly warmer during the late summer and autumn in 1976 than 1975 (Table 2).

Mean maximum river temperatures of the Clearwater River downstream from the North Fork at Lenore ranged from 2.3 C (36.1 F) in February to 19.1 C (66.4 F) in August in 1976.

The cooling effects of North Fork discharge on the lower Clearwater below the confluence was again well documented in 1976 during the summer months. Perhaps just as significant was that river temperatures remained suppressed as far downstream as Lewiston during July, August and September. The cooling effect of North Fork water in 1976 was significantly greater than in the previous two summers when multi-level outlet gate operations helped reduce the temperature difference at the confluence (Pettit 1976). Water quality related problems at Dworshak Hatchery required that discharge temperature be kept below 13 C (55 F) in an effort to reduce juvenile steelhead mortality.

Discharge temperatures from the North Fork began warming the lower Clearwater River in October and continued throughout the fall and winter (Table 2).

Table 1. Estimated total hours fished and harvest per 2-week interval, lower Clearwater during the summer census period, 1976.

Two-week Interval Beginning:	Interval number	Estimate hours fished	Species						Harvest total
			SMB	HRBT	CT	WF	SQ	SH	
25 May	11	2,093	0	1,464	56	56	225	0	1,831
6 June	12	2,079	13	416	42	0	62	0	533
20 June	13	2,020	40	606	20	20	606	0	1,292
4 July	14	1,798	306	474	72	13	180	0	1,038
18 July	15	898	0	503	18	0	135	0	656
1 August	16	728	0	524	0	0	80	0	604
5 August	17	710	128	405	0	14	178	10	735
9 August	18	1,173	47	235	0	47	94	17	440
2 September	19	1,162	116	430	0	23	47	198	814
Totals		12,661	650	5,050	208	173	1,607	225*	7,943

SMB = Smallmouth Bass
HRBT = Hatchery rainbow-juvenile steelhead
CT = Cutthroat trout
WF = Mountain whitefish
SQ = Squawfish
SH = Adult steelhead

*Adult summer run steelhead released by anglers.

Table 2. Mean weekly maximum and minimum river temperatures (C°) of four Clearwater River locations, 1976.

Week beginning	R.B. Orofino		Dworshak National Fish Hatchery Outlet		L.B. McGill		L.B. Lenore	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1/4	1.1	.8	5.1	4.6	2.7	2.2	3.9	3.3
1/11	2.0	1.7	4.6	4.0	2.9	2.6	3.6	2.9
1/18	2.8	2.1	4.9	3.8	2.9	2.5	3.3	2.5
1/25	2.9	2.1	5.9	4.6	2.4	2.2	4.2	3.5
2/1	1.2	.4	4.4	2.6	1.8	1.1	2.7	1.8
2/8	.4	.1	4.1	3.1	1.8	1.4	2.3	1.5
2/15	2.3	1.5	3.6	2.4	3.0	2.4	3.1	2.3
2/22	3.8	2.8	4.0	2.8	3.4	2.9	3.6	2.8
2/29	2.4	1.0	3.7	1.7	2.6	2.0	3.1	2.1
3/7	4.3	2.8	5.0	2.9	3.5	2.8	3.9	2.8
3/14	5.1	4.1	4.9	3.4	4.0	3.5	4.1	3.4
3/21	4.7	4.0	4.4	3.1	4.5	3.8	4.5	u.8
3/28	7.2	5.4	6.1	3.6	6.0	4.9	5.8	4.6
4/4	8.6	6.3	7.2	4.2	7.1	5.8	6.4	5.5
4/11	7.5	6.2	6.5	4.6	7.0	5.8	6.4	5.42
4/18	8.5	7.1	7.6	5.1	7.8	6.9	7.4	6.6
4/25	9.8	7.8	9.5	5.6	8.8	7.3	8.6	7.7
5/2	9.9	8.1	9.2	6.8	8.8	7.9	9.0	7.6
5/9	9.6	7.8	10.4	6.3	8.7	7.8	8.8	7.1
5/16	10.5	8.2	12.2	8.1	8.8	7.7	9.1	7.1
5/23	10.3	8.0	12.8	9.4	9.4	7.9	10.2	7.6
5/30	10.0	8.1	11.0	8.5	9.8	8.2	9.4	7.8
6/6	11.6	9.6	11.8	9.0	11.9	9.6	11.1	9.7
6/13	11.3	9.1	10.1	7.6	10.5	9.1	10.4	9.0
6/20	12.3	9.8	9.8	7.3	10.4	9.4	10.4	9.1
6/27	15.7	12.4	12.1	8.2	13.6	11.8	11.9	10.6

Table 2. Mean weekly maximum and minimum river temperatures (C°) of four Clearwater River locations, 1976. (continued)

Week beginning	R.B. Orofino		Dworshak National Fish Hatchery Outlet		L.B. McGill		L.B. Lenore	
	Max.	Min.	Man.	Min.	Max.	Min.	Max.	Min.
7/4	18.6	15.9	12.7	9.8	15.7	14.5	13.6	12.2
7/11	19.7	17.6	14.1	10.1	16.6	15.5	14.85	13.3
7/18	21.4	19.1	15.1	11.0	18.4	16.8	17.1	14.7
7/25	24.0	21.1	16.3	11.1	19.3	18.1	18.6	15.9
8/1	23.4	21.8	15.1	11.5	19.1	17.6	17.9	15.6
8/8	21.7	19.1	16.1	12.1	17.1	16.8	16.4	14.0
8/15	20.1	17.8	15.7	11.6	19.1	14.8	15.6	13.5
8/22	21.4	18.4	15.5	11.1	18.7	17.2	17.0	14.8
8/29	23.9	18.8	18.3	12.8	19.2	16.9	19.1	16.4
9/5	21.2	17.0	16.7	12.6	17.2	15.4	17.4	15.5
9/12	20.1	15.6	16.4	12.6	16.7	14.6	17.3	15.2
9/19	18.8	14.5	16.1	12.0	16.6	14.5	17.6	15.8
9/26	18.0	15.0	15.5	13.5	16.5	14.5	16.5	14.4
10/2	14.3	12.0	14.5	11.6	14.1	13.0	15.0	13.4
10/9	14.0	10.4	14.0	10.3	12.8	11.6	13.8	12.4
10/16	9.3	6.2	12.8	9.1	10.3	9.0	11.4	10.1
10/23	6.7	5.0	10.7	8.7	8.5	7.8	9.9	9.0
10/29	7.0	5.9	9.8	8.6	8.6	7.9	10.4	9.5
11/6	8.1	6.5	9.8	8.2	8.8	7.9	9.8	8.9
11/13	7.2	4.8	8.5	7.5	7.3	6.6	9.0	8.0
11/20	3.8	2.6	6.5	5.1	6.2	5.7	8.1	7.2
11/27	1.0	.2	4.4	3.0	4.5	3.9	6.6	5.5
12/4	0.3	0.0	3.9	3.0	3.8	3.5	5.8	5.5
12/11	0.5	0.1	3.7	2.9	3.3	2.4	5.1	3.9
12/18	0.7	0.1	3.6	3.0	3.5	2.8	5.1	4.4
12.25	0.5	0.0	3.5	3.0	3.5	2.0	4.5	3.5

Ice sheets had formed over the majority of slower moving stretches above Orofino by 24 November while the lower river remained ice-free the entire year.

The unseasonably warm and dry months of September, October and early November keep the resulting river temperatures much warmer than in previous years. These higher temperatures were, in part, responsible for the excellent steelhead fishing enjoyed by anglers during 1976.

Water Quality Analysis

The ranges of water quality parameters recorded by the Idaho Department of Health and Welfare (Edwin Tulloch, personal communication) at Spalding in 1976 were: pH; 6.2-7.9, dissolved oxygen, 8.9-12.4 mg/1; turbidity, 1.1-32.0 (JTU); alkalinity (as CaCO3), 14-28 mg/1; nitrate, .001-.008 mg/l; ortho-phosphate, <.001-.18 mg/1 (Table 3).

The trend towards increased oligotrophy continued during 1976. The values for total alkalinity recorded at Spalding were significantly lower than preimpoundment levels. The suppressed nutrient load of the lower Clear-water should continue due to the North Fork impoundment.

The ranges of water quality parameters recorded at Dworshak National Fish Hatchery on raw North Fork water in 1976 were: pH, 6.2-7.5; dissolved oxygen, 10.1-13.8 mg/1; total hardness (as CaCO3) 9.5-13.8 mg/1• total alkalinity (as CaCO3), 11.0-15.0 mg/l; total dissolved solids, 31-47; nitrate, .02-.18 mg/1; nitrite, .001-.003 mg/l; ortho-phosphage C.01-.04 mg/1; ammonia, <.01-.02 mg/l (Table 4).

Water quality problems related to lowered levels of dissolved minerals and salts continued to plague fish production at Dworshak Hatchery during 1976. Addition of mineral salts to the hatchery water supply was attempted in 1976. Efforts were made to increase the hardness and to provide similar water conditions found in southern Idaho (1976 Annual Report, Dworshak National Fish Hatchery, Fish and Wildlife Service). Other attempts were made to reduce elevated levels of nitrate toxicity with the addition of chloride ions lacking in raw North Fork water.

Rainbow-Juvenile Steelhead Fishery

The total estimated catch of rainoow trout-juvenile steelhead during the summer census in 1976 was 5,050 fish. This was the third highest harvest on the lower Clearwater during the 8-year investigation and 17% greater than the last 6-year average (Table 5). The cooler than normal weather conditions during the summer and lower flows provided excellent fishing on the lower Clearwater River in 1976.

Average length of rainbow-juvenile steelhead measured from anglers' creels was 270 mm (10.7 in) in 1976 (Table 6). Both the quality and average size has increased annually since Dworshak Reservoir discharge began modifying the lower river habitat (Pettit 1976). Many anglers interviewed during 1976 had trophy-size rainbow trout in their catch.

Table 3. Water quality analysis from the lower Clearwater River at Spalding during 1976. Samples were analyzed by the Idaho Department of Health and Welfare.

Date and Flows	Temp. (C)	Flows (cfs)	Dissolved Oxygen (mg/l)	pH	Turbidity (J.T.U.)	Alkalinity ($CaCO_3$)	Nitrite (NO_2)	Phosphate (P-ortho)	Total solids
16 January	2.2	35,880	10.5	6.9	32	28	.007	.18	265
27 February	2.7	22,340	10.2	6.6	7	26	.002	.01	88
24 March	4.5	28,560	12.4	7.1	7	24	.001	.03	-
30 April	7.0	30,700	11.7	6.9	7.9	28	.001	.01	37
17 May	8.9	63,000	11.7	7.7	8.5	16	.007	.03	41
24 June	10.1	41,720	12.1	6.7	3.4	14	<.01	.07	40
27 July	17.9	6,340	10.2	7.9	2.0	18	.008	.05	36
30 August	19.0	3,690	8.4	7.6	2.2	20	.002	.01	55
1 September	19.9	3,500	8.1	7.3	1.2	21	.001	<.01	55
21 October	9.0	3,760	10.6	6.2	1.3	28	.002	.17	64
8 December	5.3	9,580	12.0	7.3	1.3	18	.001	<.001	45

Table 4. Water quality analysis of North Fork Clearwater River sampled at Dworshak National Fish Hatchery, 1976.

Date	Temp (C^{o})	pH	Dissolved Oxygen	Hardness mg/l $CaCO_3$	Alkalinity mg/l $CaCO_3$	TDS mg/l	Nitrate (NO_2)	Nitrite (NO_2)	Phosphate (ortho-P)	Ammonia
17 January	4.1	7.5	13.4	11.7	13.8	47	.13	<.001	<.01	-
26 February	3.9	6.3	11.3	11.8	-	31	0.4	.003	.04	-
31 March	6.1	6.9	12.4	13.8	15.0	32	.18	<.001	<.01	-
19 May	12.2	6.2	11.5	12.2	13.6	33	.07	<.001	.04	-
17 June	8.9	7.5	11.2	12.1	15.0	32	-	<.001	-	<.01
16 July	13.1	7.3	10.7	9.2	11.2	34	.17	.002	.01	<.01
9 August	12.2	7.2	10.5	10.1	11.0	32	.04	.001	-	0.0
19 October	11.9	6.7	10.9	9.5	13.5	31	.04	<.001	.01	<.01
14 November	10.0	6.9	10.1	9.8	12.0	33	.03	<.001	-	.02
15 December	5.6	7.0	11.0	11.5	13.0	39	.02	.001	.02	0.0

Table 5. Estimated effort and harvest during the summer census periods and of smallmouth bass and rainbow-juvenile steelhead, lower Clearwater River and North Fork below Dworshak Dam, 1969-1976.

Year	Summer census period	Estimated effort (hours)	Estimated summer harvest	
			Smallmouth bass	Rainbow trout
1969[1]	8 June - 13 Sept	11,556	6,782	92
1970	26 April - 12 Sept	10,665	3,724	772
1971	11 April - 11 Sept	9,249	1,835	6,812
1972[2]	9 April - 23 Sept	11,845	2,671	2,805
1973	8 April - 22 Sept	13,150[3]	1,434	8,670
1974	7 April - 21 Sept	6,427	1,031	2,409
1975	25 May - 13 Sept	7,377	499	1,857
1976	25 May - 25 Sept	12,661	650	5,050

1 - Census began on 8 June
2 - Season opened for trout on the lower Clearwater River on 27 May 1972, and 26 May 1973; previous years were year around fishing. North Fork below Dworshak Dam closed in 1972.
3 - Includes 1,241 hours by chinook fishermen

Table 6. Average total length of juvenile steelhead in anglers' creels, lower Clearwater River, 1971-1976.

Year	Sample period	Sample size	Average length mm	(in)
1971	11 April - 12 Sept.	818	180	7.1
1972	4 June - 24 Sept.	206	219	8.6
1973	26 May - 30 Sept.	724	202	8.0
1974	7 April - 21 Sept.	128	217	8.5
1975	25 May - 13 Sept.	87	243	9.6
1976	25 May - 15 Aug.	200	270	10.7

Mature resident rainbow trout again entered the fish ladder at Dworshak National Fish Hatchery in the spring of 1976. These individuals (n=211) averaged 346 mm (13.6 in) during the 1976 spawning period. The spawn from these returning rainbows is not presently being taken at Dworshak Hatchery, but this policy may be changed in the future to enhance resident fisheries.

Smallmouth Bass Fishery

Anglers harvested an estimated 650 smallmouth bass during the 1976 summer census period (Table 5). This represents a 15% increase over the 1975 catch. The bulk of the harvest occurred between Potlatch Creek and Peck (Fig. 1) and occurred during mid and late summer. Anglers did not increase their effort in Section 1 (slack water arm of Lower Granite Reservoir) where project divers have observed increased numbers of adult smallmouth.

The average length of bass (n=42) measured from anglers' creels in 1976 was 284 mm (11.2 in).

Steelhead Catch-and-Release Research, 1975-1976

During the 1975 fall catch-and-release fishery on the lower Clearwater River, project personnel and cooperating sports fishermen caught, tagged and released 230 adult summer steelhead. Of these, 152 were determined to be of hatchery origin based on fin erosion and other external marks. The remaining 78 were thought to be of wild stock from Clearwater River tributaries. Anglers fought steelhead to exhaustion, then tagged the fish with a Monel steel jaw tag. Tagging procedures prior to release are described in the previous Completion Report (Pettit 1976).

Anglers fishing during the 2-month (1 October to 30 November) catch-and-release steelhead fishery reported recapturing four jaw-tagged fish. The first recovery was a small, wild female originally caught by fly and

recaptured by hotshot 18 days later. Initially tagged on 7 October, it was caught the second time after moving approximately 100 m upstream.

The second recovery, an 88.9 cm (35 in) hatchery male, was originally caught on 1 October with a hotshot, and recaptured 50 days later by the same angler. The fish had moved upstream approximately 2 km (1.2 mi) between captures. This same individual was subsequently recovered at Dworshak Hatchery on 27 April 1976.

The third steelhead was caught on 1 October by a fly fisherman and later recaptured by hotshot on 11 November Approximately 19 km (12 mi) upstream. The fish was a wild, 71 cm (28 in) male.

A fourth steelhead, caught and tagged on 22 November, was recaptured by a Nez Perce Indian in Mission Creek on 8 March 1976. The small, wild male (64 cm; 25 in) moved upstream 3.4 km (2.1 mi) and then entered Lapwai Creek sometime prior to its recapture. Several other jaw-tagged steelhead were reported to have been captured during March and April on Mission Creek, but we were unable to secure the tag numbers from Nez Perce tribal members.

During the 1976 spring spawning operations at Dworshak Hatchery, 56 jaw-tagged steelhead were recovered (Table 7). This figure accounts for 36.8% of the 152 steelhead determined to be of hatchery origin which were caught in the lower Clearwater River in the fall of 1976.

During January and February 1976, project personnel fishing on the Snake River above the slack water arm of Lower Granite Reservoir tagged and released 36 hatchery steelhead. All the fish were tagged and released from a boat using conventional hotshot fishing techniques. Release sites were located within the first 24 km (15 mi) of free-flowing river above Asotin Creek (Fig. 1). Hatchery steelhead destined for spawning at Dworshak Hatchery often overwinter in the Snake River above Lewiston (Pettit 1976).

A single individual was recaptured during the 2-month tagging period on the Snake River. The fish was a wild female, 83 cm (33 in) in length, originally caught on 3 January and recaptured 20 days later approximately 200 m (218 yd) upstream.

Another recapture from the Snake River deserves mention. Several of the professional steelhead guides cooperating in the tagging program on the Clearwater River also tagged 14 summer steelhead on the lower Salmon River in October 1975. A wild female tagged and released on 15 October at Deer Creek (river km 21) was recaptured at Dug Bar in the middle Snake's Hells Canyon on 28 December 1975. The fish dropped downstream out of the Salmon River and was caught approximately 9.6 km (6.0 mi) upstream from the Salmon confluence. None of the other steelhead tagged on the Salmon River were either recaptured or recovered at a hatchery facility.

Of the 36 hatchery steelhead tagged and released on the Snake River, 19 were subsequently recovered at Dworshak Hatchery during 1976 spawning operations. This represents a 52.8% return on the fish determined to be of hatchery origin overwintering in the Snake River (Table 7).

Table 7. Tag number, release site and date of adult summer run steelhead captured and released by anglers on the lower Clearwater River and Snake River above Lewiston, Idaho during the 1975-1976 fish run. All tag recoveries occurred at Dworshak National Fish Hatchery. Trial number refers to the experimental number assigned to female steelhead used in the egg incubation trials.

Tag No.	Tagging site (km)	Date tagged	Sex	Length (cm)	Method	Date recovered	Days out	Trial No.
Z0053	CWR-62.7	11/09/75	M	76.2	Lure	03/03/76	115	
Z0374	SR-20.9	12/19/75	M	61.0	Lure	03/29/76	101	
Z1072	CWR-29.0	11/18/75	M	81.5	Lure	03/23/76	136	
Z1017	CWR-40.2	11/08/75	F	75.9	Lure	03/29/76	142	16
Z2364	CWR-20.9	11/28/75	M	90.4	Lure	03/29/76	122	
Z2394	CWR--6.0	11/15/75	M	95.3	Lure	02/23/76	129	
Z0308	CWR-20.9	11/11/75	M	70.4	Lure	04/06/76	146	
Z0348	CWR--6.0	10/31/75	F	64.5	Lure	04/06/76	157	12
Z2096	SR-22.5	01/31/76	M	82.6	Lure	04/06/76	67	
Z2028	CWR-16.9	10/25/75	F	84.3	Lure	04/06/76	163	17
Z1213	SR-13.7	02/09/76	M	71.1	Lure	04/06/76	57	
Z1083	CWR--9.8	10/29/75	F	81.8	Lure	04/13/76	167	4
Z1214	SR-20.9	12/12/75	F	77.7	Lure	04/13/76	123	15
03833	CWR--6.0	10/13/75	F	78.2	Lure	04/06/76	157	14
10226	CWR-29.0	11/01/75	F	83.6	Lure	04/06/76	156	9
Z1218	SR-18.2	01/03/76	F	82.6	Lure	04/13/76	101	11
Z1264	CWR-33.8	11/08/75	M	71.1	Lure	04/13/76	147	
Z1279	CWR-10.8	11/09/75	F	85.1	Lure	04/13/76	156	
Z1059	CWR-48.8	10/01/75	F	80.0	Fly	04/13/76	196	3
Z1229	CWR-11.3	09/18/75	M	78.7	Fly	04/13/76	207	
Z2025	CWR-29.0	11/04/75	M	91.9	Lure	04/13/76	161	

Table 7. -- (continued)

Tag No.	Tagging site	Date tagged	Sex	Length (cm)	Method	Date recovered	Davs out	Trial No.
Z2363	CWR-20.9	11/19/75	F	87.6	Lure	04/13/76	140	
Z2031	CWR-38.0	10/19/75	M	88.9	Lure	04/13/76	177	
Z1292	CWR--9.8	10/12/75	F	80.E	Lure	04/20/76	184	1
Z2092	CWR-33.8	11/16/75	F	83.8	Lure	04/13/76	149	2
Z2074	CWR-29.0	11/08/75	M	74.4	Lure	04/13/76	157	
Z1049	CWR-34.4	10/07/75	M	86.6	Fly	04/13/76	189	
Z2398	CWR--9.8	10/01/75	M	99.1	Lure	04/20/76	203	
Z2365	SR-12.6	02/07/76	F	83.8	Lure	03/23/76	45	8
Z1227	CWR--9.8	11/26/75	F	86.9	Lure	04/20/76	146	10
Z1242	CWR--7.4	11/28/75	M	73.2	Lure	04/20/76	144	
Z2100	SR-12.6	02/21/76	M	88.9	Lure	04/20/76	59	
Z0383	CWR-10.8	11/15/75	M	66.8	Lure	04/20/76	157	
Z1263	CWR--7.4	11/05/75	F	83.1	Lure	04/20/76	167	7
Z2003	SR-18.2	01/02/76	M	88.9	Lure	04/20/76	109	
Z1260	CWR-48.8	10/07/75	M	69.1	Fly	04/20/76	196	
Z2088	SR-13.7	02/09/76	M	90.4	Lure	05/04/76	86	
Z1296	CWR-11.9	11/15/75	M	85.1	Lure	04/29/76	161	
Z1032	CWR--6.0	10/28/75	F	79.2	Lure	04/20/76	175	13
Z2030	CWR--7.4	10/28/75	M	86.4	Lure	04/20/76	175	
Z1278	CWR-38.0	10/30/75	M	64.0	Fly	04/20/76	173	
Z1068	CWR--8.0	10/28/75	M	66.8	Lure	04/20/76	175	
Z0033	CWR-19.3	10/11/75	M	66.3	Fly	04/20/76	195	
Z2098	SR-12.6	02/07/76	M	101.1	Lure	04/20/76	73	
Z2051	CWR-11.3	09/28/75	M	90.7	Fly	04/20/76	206	
Z1211	SR-11.6	01/02/76	M	67.6	Lure	04/20/76	109	
Z2400	CWR-11.9	11/15/75	M	99.1	Lure	04/27/76	164	
03850	CWR-16.9	11/19/75	F	81.5	Lure	04/27/76	171	5

Table 7. -- (continued

Tag No.	Tagging site (km)	Date tagged	Sex	Length (cm)	Method	Date recovered	Day out	Trial No
Z2038	CWR--8.0	10/28/75	F	90.4	Lure	04/27/76	183	19
Z1094	CWR-16.9	11/02/75	M	71.1	Lure	04/27/76	177	
Z0290	SR-19.3	12/14/75	M	71.1	Lure	04/27/76	135	
Z2079	CWR-29.0	11/12/75	M	93.0	Lure	04/27/76	167	
Z0093	CWR-20.9	11/22/75	F	69.9	Lure	04/27/76	157	20
Z0022	CWR-41.8	10/20/75	F	77.0	Fly	05/11/76	204	22
Z2027	CWR-11.3	11/09/75	F	81.3	Lure	04/27/76	170	23
Z0347	CWR-10.8	11/19/75	M	63.5	Lure	04/27/76	160	
Z2072	CWR-33.8	11/09/75	M	96.5	Lure	05/30/76	204	
Z0386	CWR-10.8	11/15/75	M	72.4	Lure	04/27/76	164	
Z1273	CWR--7.4	11/22/75	F	82.6	Lure	04/27/76	157	
Z2035	SR-11.6	01/25/76	F	81.5	Lure	04/25/76	93	
Z1297	CWR--6.0	10/28/75	F	76.7	Lure	04/27/76	183	18
Z1285	SR-11.6	01/25/76	F	74.9	Lure	05/18/76	114	21
Z1091	CWR-16.9	11/19/75	M	70.6	Lure	04/27/76	160	
Z0354	CWR-57.1	11/30/75	M	65.5	Lure	03/23/76	114	
Z1202	SR-12.6	01/31/76	M	72.4	Lure	05/04/76	94	
Z0239	CWR-20.9	11/11/75	M	66.0	Lure	05/04/76	175	
Z0296	SR-23.3	12/14/75	M	67.6	Lure	05/04/76	142	
Z1289	CWR--6.9	10/01/75	M	94.0	Lure	05/04/76	217	
Z2084	CWR-33.8	11/29/75	M	84.6	Lure	05/04/76	154	
00079	SR-13.0	02/09/76	F	78.7	Lure	05/04/76	85	24
Z1225	SR-13.7	02/09/76	M	67.3	Lure	05/04/76	85	
Z2044	SR-13.7	02/09/76	M	90.2	Lure	05/04/76	85	
Z1012	CWR-61.6	10/04/75	F	73.7	Lure	05/04/76	213	
Z0236	CWR-19.0	11/19/75	F	83.3	Lure	05/04/76	168	
Z0246	CWR-34.4	10/10/75	M	68.6	Fly	05/25/76	228	

The total number of steelhead tagged and released from both the Snake and Clearwater Rivers determined to be of hatchery origin was 188. The 75 tag recoveries made at Dworshak Hatchery represented a 40% return on the total number of hatchery steelhead tagged in 1975-1976.

The Clearwater River tagging project provided workers with an unexpected observation on steelhead behavior. During the spring period of migration over the lower Snake dams, six of our catch-and-release, jaw-tagged steelhead were recovered in the adult separators on Little Goose and Lower Granite fish ladders (Emil Slatick, personal communication). All six individual had been caught and released by anglers fishing on the lower Clearwater River between river km 6.7 and 20.9 (mile 4.2 and 13). These fish apparently moved out of the lower Clearwater after release, passing downstream through Lower Granite Reservoir. How these fish passed the Lower Granite Lock and Dam is unknown, but one individual continued downstream through the Little Goose impoundment and was observed in the fish ladder at Little Goose Dam on 27 March 1976 (Table 8). This same individual was again observed two more times in the adult separator at Lower Granite on 1 April and 23 April.

Table 8. The capture date, description, location of tagging of six adult steelhead caught and released during the 1975 fall steelhead season on the lower Clearwater River and recovered the following spring from the fish ladders at Lower Granite and Little Goose Dams on the lower Snake River.

Tagging date	Description and length (cm)	River mile	Recovery date	Project ladder
10/01/75	wild-F-71	4.2	3/23/76	Lower Granite
10/03/75	hat.-M-66	10.5	4/02/76	Lower Granite
10/08/75	hat.-M-66	4.2	3/31/76	Lower Granite
10/14/75	wild-F-58	4.2	4/11/76	Lower Granite
11/22/75	hat.-M-64	10.5	5/02/76	Lower Granite
10/13/75	hat.-M-61	13.0	3/27/76	Little Goose
			4/01/76	Lower Granite
			4/23/76	Lower Granite

Whether or not this fall-back behavior is an artifact of capture and release, or whether these individual steelhead were disoriented fish from a different drainage is not known. The fact that all six steelhead were smaller, 1-ocean fish, and that two individuals had clipped pelvic fins, may lead us to believe the latter explanation. The pelvic clip was used at Pahsimeroi Hatchery (Mel Reingold, personal communication) for that 1-ocean group of returning fish which also happened to be of Clearwater stock. An increased level of straying and disorientation may be a result of releasing the North Fork race of steelhead in the upper Salmon drainage.

Radio Tracking Study

During January and February, 1976, project personnel, in cooperation with

University of Idaho Fishery Research Unit workers, initiated a radio tracking investigation on the lower Snake River above Lower Granite pool. The overwintering behavior of the North Fork Clearwater race of steelhead in the middle Snake River has been well documented, but their migration behavior and length of temporary residency remained unknown. Using radio telemetry techniques, we were able to determine the timing and return percentage to the Clearwater River of hatchery steelhead overwintering in the Snake River above Lower Granite pool (Fig. 1). Workers selectively radio tagged larger, 2-ocean adults determined to be of hatchery origin in an attempt to mark only Dworshak Hatchery fish. All steelhead used in the study were captured by hook-and-line (hotshot) from jet boats and released at the capture site (Fig. 2). We began monitoring movements immediately after released and continued to track fish through the winter and spring migration period. In addition to radio tags. all fish had jaw tags placed on the mandible to aid recovery at Dworshak Hatchery during spawning operations.

Project personnel caught and released 12 adults determined to be of Dworshak Hatchery origin. Two of the transmitters placed in overwintering fish failed to operate, and these steelhead were never recovered. The remaining ten individuals were monitored for varying lengths of time during the remainder of the overwintering and spring migration period.

We found that released fish remained in the same approximate location after release for the entire overwintering period. Based on tracking data, the spring movement period began in mid-March, when all steelhead began dropping downstream towards the Clearwater confluence. Sixty percent of the radio-tagged steelhead returned to either the North Fork or Dworshak Hatchery.

Four individuals were tracked without difficulty when they moved into the Clearwater River and subsequently into the hatchery during April. A fifth individual was monitored to a location in the North Fork below Dworshak Dam where it remained until reservoir discharge increased in April. The individual then moved out of the North Fork with the increased flows and was tracked back down the lower Clearwater and into Lower Granite pool where it was lost.

One individual, lost shortly after it began moving downstream in the Snake, was found again in late March in Lower Granite Reservoir about 2 km above the dam. This individual was subsequently recovered at Dworshak Hatchery on 14 April.

The remaining four steelhead were lost in the impounded confluence area of the Snake and Clearwater Rivers and never recovered.

Except for the two steelhead with inoperative transmitters, all the remaining fish apparently survived capture successfully and appeared to behave normally after release. Movement back to the Clearwater River supports the theory that overwintering in the Snake River above the confluence is normal behavior of the North Fork race of summer steelhead, and not increased levels of straying caused by the filling of Lower Granite pool.

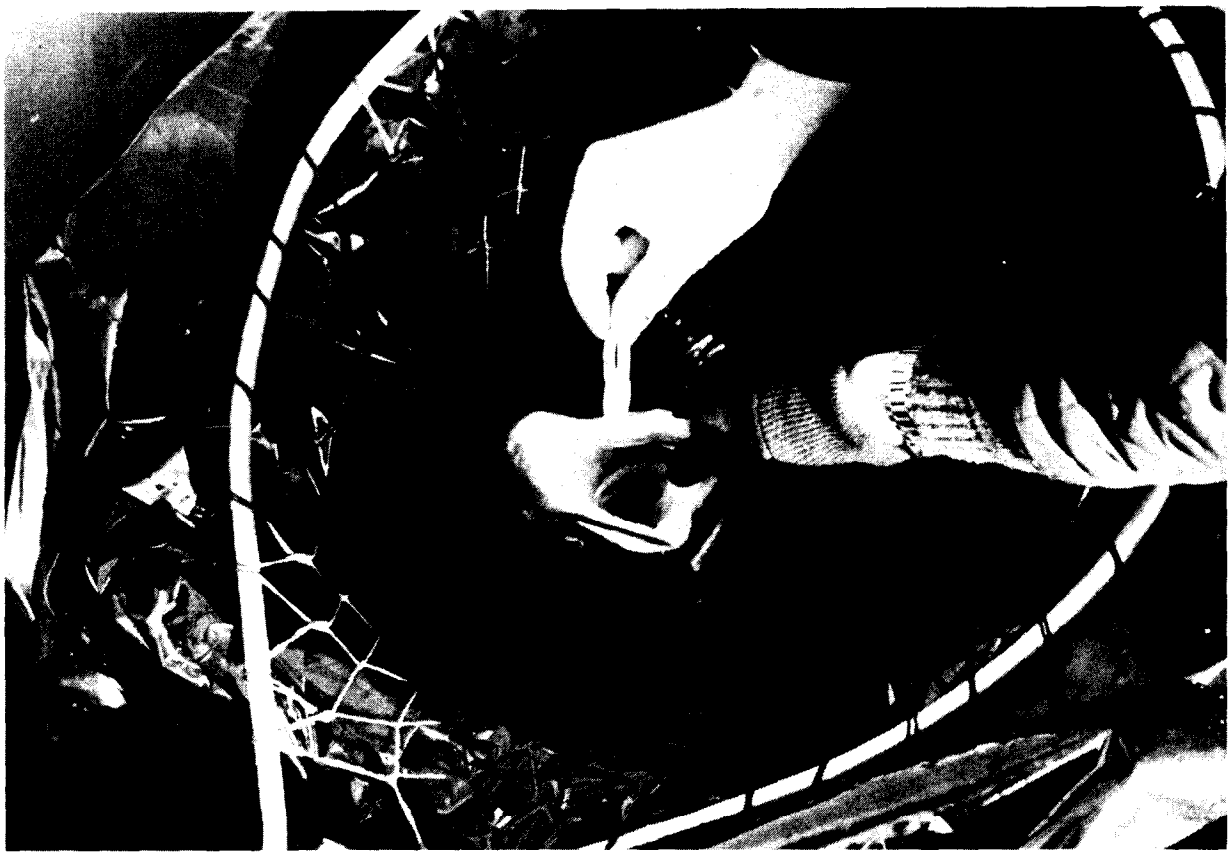

Figure 2. Workers inserting an AVM radio transmitter into the stomach of an adult summer steelhead. The fish was tagged after capture by project personnel on the Snake River near Asotin.

Catch-and-Release Spawning Study

In 1974 we designed a spawning study with the cooperation of Dworshak Hatchery personnel to closely examine the egg survival and development from female steelhead which had been caught and released by anglers on the Snake and Clearwater Rivers. Although the results gave no indication that the eye-up percentages of eggs from released female steelhead were less than non-played fish, the sample size (n=6) was very small (Pettit 1976).

The identical controlled experiment was repeated during the 1976 spawning at Dworshak Hatchery. Unlike the precious year when only 24 hatchery steelhead were tagged after release, the 188 fish tagged during the 1975-1976 fish run provided a statistically useful sample size.

Twenty-four tagged females, determined to be ripe, were spawned individually. An untagged female of the same approximate size served as a control. After air spawning the played and nonplayed fish in separate containers, their eggs were fertilized by the same male. Eggs were allows to water harden, then placed in marked incubation trays. Each experimental pair was then followed through the eye-up stage and the numbers of developing and dead eggs counted.

A t-test for paired comparisions was used to test whether the mean of sample differences between pairs of eye-up percents was significantly different from a hypothetical mean of zero. An IBM 370 computer was used to run the statistical comparisons.

The average number of green eggs per experimental female was 5,880 and 7,830 eggs per fish for the controls. The mean number of days between original capture and recovery at the hatchery was 152, and ranged between 45 and 205 days (Table 7).

Paired comparison for the percentage of eyed eggs between played and non-played females did not significantly differ (t-test, p 0.05) during the incubation trials. The mean number of eyed eggs per experimental female steelhead was 5,180, and 5,330 eyed eggs per control fish. The mean percent of eyed eggs for the catch-and-release females was 86.5% and ranged from 25.0% to 98.3% (Table 9). The mean percentage for the unplayed females was 86.2% and ranged between 40.0% and 99.2%.

The nonsignificant difference in the viability or development of eggs between female steelhead trout which were caught and relased and unplayed fish indicates, barring gross injury, released females can return to their target spawning streams and reproduce successfully. Although the experiment dealt only with hatchery reared steelhead, I believe that native, wild steelhead released by anglers would demonstrate similarly successful spawning capabilities. The holding pond environment and weekly automated sorting procedures used at Dworshak Hatchery are most likely comparable to the rigors of natural reproduction in the wild. Some females at Dworshak Hatchery are subjected to as many as eight successive weeks of handling prior to spawning. Hooking and releasing has been shown to cause a greater stress on hatchery fish than on wild rainbow trout (Wydoske, Wedemeyer and Nelson 1976). However, returning adult summer steelhead to the Snake River system have encountered severe

Table 9. The eyed egg percentage for eggs taken from experimental pairs of played and unplayed female steelhead during the 1976 spawning return at Dworshak National Fish Hatchery.

Trial number	Played percentage	Unplayed percentage
1	96.2	78.6
2	97.4	94.3
3	94.0	92.0
4	95.2	96.8
5	95.7	97.9
6	96.0	97.6
7	94.0	99.2
8	94.3	98.8
9	51.3	90.7
10	97.7	56.4
11	97.7	98.5
12	33.3	40.0
13	95.0	88.4
14	98.3	44.1
15	92.5	98.0
16	97.1	99.0
17	90.2	80.0
18	65.0	95.8
19	94.6	96.6
20	92.0	99.0
21	96.4	95.2
22	25.0	78.7
23	95.4	64.0
24	90.9	88.7
Mean	86.5	86.2

selective processes in 2 or more years of river and ocean migrations, and any physiological differences between hatchery and wild fish should be reduced considerably.

Several experimental pairs and individual females from both groups had unusually low eyed percentages during the trials. We carefully examined all females during the spawning process and failed to observe any gross abnormalities in their reproductive organs or products. However, the quality of sperm from hatchery males used during the trials was questionable at times. Due to the critically low number of returning adults during the 1976 run, project personnel were unable to be as selective as desired in choosing experimental males. On several occasions, bloody sperm was encountered during the fertilization of experimental pairs. It is the author's opinion that poor quality sperm most likely was responsible for the low values. Unfortunately, sperm quality was not recorded during the fertilization of experimental pairs.

As steelhead trout management problems become more complicated and angler attitudes change in the western states and British Columbia, catch-and-release regulations should gain in popularity. No kill restrictions applied to steelhead fisheries also may be a necessity to conserve endangered wild populations, especially in the Snake River tributaries of Oregon, Washington and Idaho. Once the problem of angler recognition between wild and hatchery reared steelhead is addressed and solved, catch-and-release regulations could be used to protect fish of wild stocks, yet permit the harvest of hatchery fish.

Discussion on Hooking Mortality

The 40% tag recovery at Dworshak Hatchery of caught and released hatchery steelhead, taken in its strictest sense, would indicate to the reader that 60% of the released fish failed to survive. I believe that although hooking mortality obviously exists, it remains at a low level on adult steelhead and does not account for the missing tags. The number of instances where adult steelhead were severely injured or killed by project anglers using barbless, single hooks on artificial flies and lures was minimal. During the 1975 fall steelhead season, sportsmen reported killing two steelhead and project personnel, a single individual. There have been no reported cases of anglers or other sportsmen finding the carcass of a released, jaw-tagged steelhead on the Snake or Clearwater Rivers during the 1975-1976 fish year. Although water temperatures and current hydraulics may act to prevent fish carcasses from beaching or floating, it is perhaps significant tnat no tagged carcasses have ever been found.

I am now aware of considerable error in proper hatchery fish identification. This was especially true with those steelhead caught and released by cooperating sportsmen and professional steelhead outfitters. The eroded dorsal fin was the chief method used to identify a hatchery reared steelhead and I found that many anglers were mistaking gillnet damaged fins for an indication of hatchery origin. I am not aware of a method to estimate the magnitude which this identification error may have caused, but casual discussion with cooperating sportsmen indicated that it was considerable in some cases. The percent return to Dworshak Hatchery could have been significantly reduced because of this bias. Future tagging studies on the Clearwater River should attempt to deal with this problem.

A main Clearwater River release of smolts at Dworshak Hatchery in 1973 may have interfered with the normal homing mechanism of returning adults in 1976. Because of unusually high saturation levels of nitrogen (126%) below Dworshak Dam, a North Fork release was ruled out by Fish and Game and hatchery personnel. Straying of hatchery adults upriver past the North Fork was reported by Ball and Pettit, 1974. It can be assumed that the normal occurrence of hatchery bypass would be increased due to a main river release of smolts. If this is the case, a loss of tagged steelhead bypassing the hatchery could have significantly reduced the return percentage at Dworshak in 1976. Returning adults in spring 1977 will be from a normal North Fork release and recoveries from tagging studies will be compared to the 1976 project.

Radio and sonic transmitters offer researchers the only accurate evaluation of the fate of released steelhead after capture. Other workers on the Snake and Clearwater Rivers have not reported hooking mortalities associated with radio and sonic tagging investigations. Bjornn and Ringe (1974) caught and released 19 adult steelhead by hook and line methods in the Lower Granite pool area prior to the filling of the reservoir. These individuals were tagged with sonic transmitters and subsequently monitored as Lower Granite pool filled. None of the tagged steelhead died immediately after capture, and all were tracked as they moved out of the newly impounded area. None of the radio tagged steelhead released in the Snake River in 1976 by project personnel were identified as mortalities immediately after release. All but two individuals were successfully monitored for considerable lengths of time after release.

In the latter part of May, 1976, it was discovered that adult hatchery steelhead were either escaping from the holding ponds or being stolen by vandals. Seven jaw-tagged fish observed on 17 May during spawning operations and returned to the holding ponds, were not recovered the following week. Neither were the individuals recovered as pond mortalities after draining in June. It is possible that adults were entering the fish ladder during the 1976 run, and escaping prior to observation on the sorting table. This loss could have lowered the tag recovery percentage had tagged fish been among these individuals. Hatchery personnel have corrected the problems with the trap barrier, and adults should not escape during the 1977 spawning run.

In summary, I believe that the failure of a tagged steelhead to return to Dworshak Hatchery does not necessarily mean the fish died as a result of being captured and released by sports anglers. In order to reduce identification bias on 1976-1977 tagging studies, workers will attempt to better educate cooperating anglers in the identification of hatchery reared steelhead. At the same time the other major causes for possible recovery losses, main Clearwater smolt releases and adult escapement from the hatchery, should not occur during the 1977 return to Dworshak Hatchery.

Dworshak Hatchery Return 1976

The catch-and-release steelhead regulations on the lower Clearwater River in 1975 did not provide workers with the information necessary to accurately estimate the number of hatchery steelhead in the 1975-1976 fish run. Project personnel and anglers cooperating in the catch-and-release tagging program caught a total of 230 steelhead on the lower river during October and November, 1975. Based on fin erosion, we determined that 152 were of hatchery origin

for approximately 66% of the number tagged. If the assumption is made that 230 steelhead tagged and released was a representative sample, the approximately 65% to 70% of the total run was of hatchery origin in 1976.

The total of 1,858 fish were handled at Dworshak Hatchery during the 1976 spawning operation. Because of the probable escapement of adults from the holding ponds, the actual return may have been somewhat greater. Of the 1,858 adults returning, 1,726 (92.9%) were measured to the nearest 0.1 inch (fork length). The 1,726 measured consisted of 1,080 (62.6%) females and 646 (37.4%) males.

Workers at Dworshak Hatchery read scales from a total of 776 adults from the 1976 return. Based on the number of ocean rings, an estimated 5.8% of the sample were 1-ocean steelhead. Ninety-one percent (90.9%) were determined to be 2-ocean and 3.3%, 3-ocean fish (Joseph Lientz, personal communication). Because of the unusually poor condition of Dworshak steelhead scales due to reabsorption after 8 to 9 months in fresh water, a length frequency distribution of returning adults most likely provides a more accurate analysis of age class composition (Fig. 3).

Using 71 cm (28 in) as a cutoff length to separate 1-ocean steelhead from those returning after 2 or more years in the ocean, the 1976 return was comprised of approximately 18.6% 1-ocean fish. The remaining 81.4% were comprised of 2-ocean and 3-ocean individuals (Joseph Lientz, personal communication). Although the 2-ocean percentage was unusually low due to poor downstream survival in 1973, the greater than normal 1-ocean return in 1976, most likely indicates that the 1977 return should be considerably stronger than that of the previous 2 years.

The average length for returning adults in the 1976 spawning return was 79.8 cm (31 in). The average length for females was 79.9 cm (31.5 in) and 79.4 cm (31.3 in) for males. Because the unusually high percentage of 1-ocean adults in 1976 return, the 79.8 cm average length was the smallest reported in the six years of spawning at Dworshak Hatchery (Pettit 1976). As in all years, except 1974, the existence of a strong bimodal length distribution characterized the 1976 return (Fig. 3).

The percent return of Dworshak adults from the last completed release (1972) was estimated to be .340% (Table 10). None of the three completed returns have surpassed 1.0%. The estimated number of steelhead returning in 1976 from the three age classes, was based on length-frequency distributions, scale readings and tetracycline marking.

ACKNOWLEDGEMENTS

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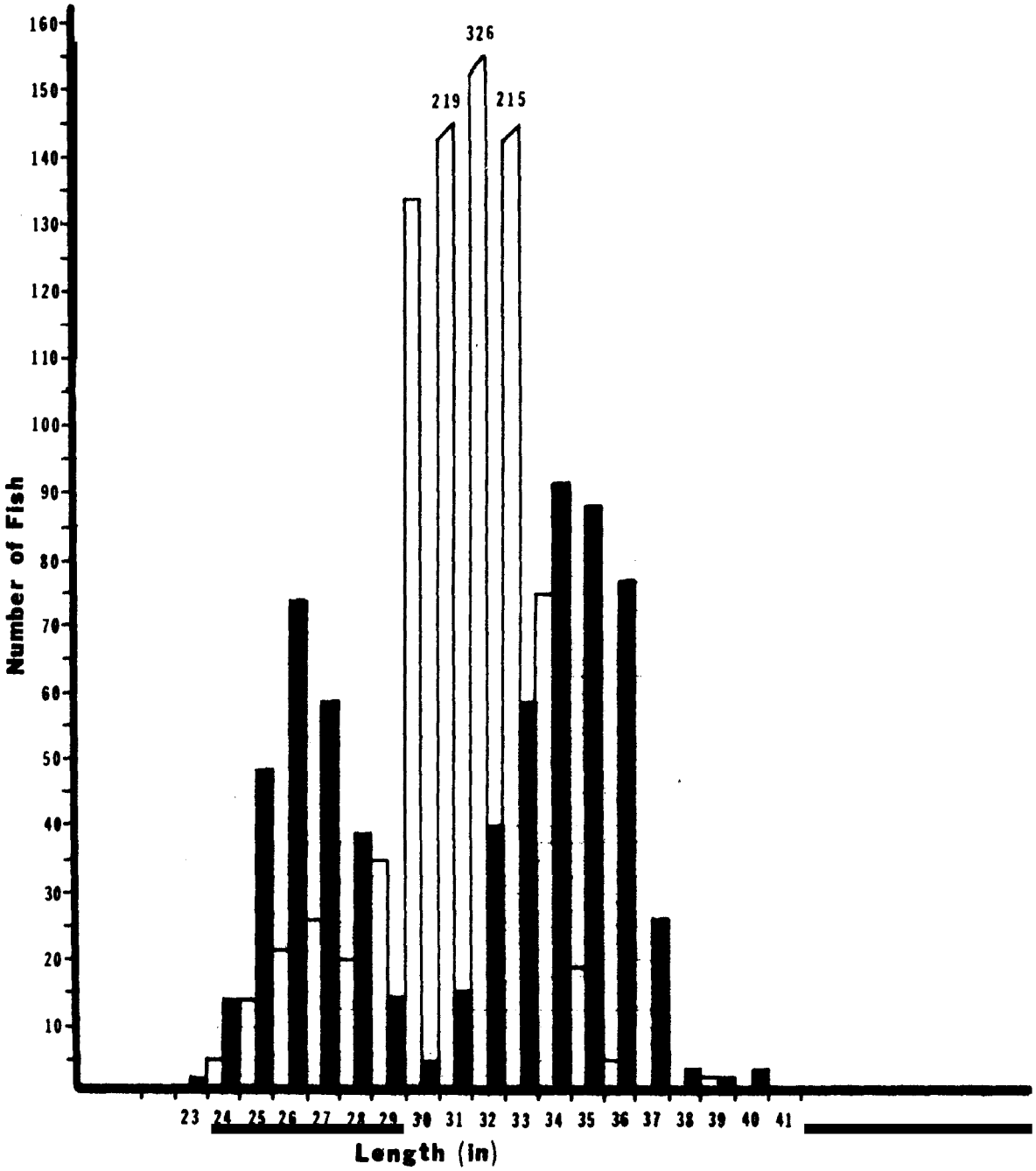

Figure 3. The length frequency of females and males (shaded bars) returning to Dworshak National Fish Hatchery during the 1976 spawning operations.

Table 10. Number and percent of adult steelhead returns to the Clearwater River from Dworshak smolt releases. Returns include hatchery spawning run and harvest in lower Clearwater River.

Release year	No. smolts	One ocean	%	Two ocean	%	Three ocean	%	Total	%
1970	1,371,543	(1972) 834	.061	(1973) 9,916	.723	(1974) 906	.066	11,656	.853
1971	3,143,573	(1973) 1,421	.045	(1974) 8,767	.280	(1975) 34	.001	10,222	.325
1972	976,554	(1974) 1,872	.192	(1975) 1,393	.143	(1976) 55	.006	3,320	.340
1973	2,199,899	(1975) 414	.020	(1976) 1,450	.066				
1974	3,397,859	(1976) 345	.010						

Special appreciation is extended to Dworshak National Hatchery Manager Wayne Olson and his staff, for without their assistance and cooperation, the investigation would not have been possible. The help and computer time for data analysis donated by Dr. Dale Everson and Deborah Amos is gratefully acknowledged.

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JOB PERFORMANCE REPORT

State of Idaho Name: DWORSHAK FISHERIES STUDIES

Project No. DSS-29-7 Title: Evaluation of the Limnological Characteristics and Fisheries of Dworshak Reservoir

Job No. 4

Period Covered: 1 March 1976 to 28 February 1977

ABSTRACT

In 1976, minimum pool 440 m (1,445 ft) was reached on 29 March after winter drawdown. Filling continued through the spring until maximum elevation was achieved on 11 July. Due to the drought conditions during the late summer and fall, pool evacuation was somewhat reduced in 1976.

Recreationists spent an estimated 259,930 hours on Dworshak Reservoir during the 1976 census period (January-September). Anglers spent an estimated 126,750 hours fishing while other recreationists spent 120,740 hours pleasure boating, water skiing, camping and picnicking in 1976.

Fishermen spent an estimated 126,750 hours to catch 66,440 fish during the 1976 census period. Boat anglers harvested 83% of the estimated catch and accounted for 84% of the effort. The average number of fish caught per hour of effort were 0.61 and 0.59 for boat and shore anglers, respectively. We estimated that a total of 37,900 rainbow catchables; 12,900 unmarked rainbows; 14,604 kokanee; 1,490 cutthroat, and 2,190 smallmouth bass were caught by anglers during the 9-month census period.

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OBJECTIVES

To assess the survival and growth characteristics of all fish populations in the reservoir and to relate this to selected environmental parameters.

To depict the seasonal distribution of availability of fish and relate this to water stratification, withdrawal and spawning movements.

To evaluate the availability, suitability, and use of fish spawning areas and to recommend mitigation programs which will maximize the potential of these areas.

To measure and assess the angler use and harvest of reservoir fishes as a means of measuring the success of stocking and other management programs.

To measure all water-oriented recreation use on the reservoir.

INTRODUCTION

Physical Description

Dworshak Dam and Reservoir is located on the North Fork of the Clearwater River near Orofino, Idaho. The dam, located at river km 3.1 (mi 1.9), created an impoundment 86.3 km (53.6 mi) long, encompassing 6,919 hectares (17,090 acres) with a gross storage capacity of 3,468,000 acre feet at maximum pool (elevation 488 m msl). The reservoir has a maximum width of 2,743 m (9,000 ft) an average width of 547 m (1,800 ft). Fluctuations of the water level occurs seasonally with a total drawdown of 47 m (155 ft) to an elevation of 440 m (1,445 ft) msl. At minimum pool elevation, the reservoir shrinks to only 3,663 hectares (9,047 acres).

The 282 km (175 mi) of reservoir shoreline is characterized by steep unstable slopes which are continually slumping into the reservoir during periods of fluctuation. Several areas of severe shoreline slumping occur at full pool elevation and may take years to stabilize. Shoreline vegetation is predominated by coniferous forest or an earlier seral stage.

Reservoir Storage and Fluctuation

The reservoir began filling in September, 1971, and was held at 469 m (1,540 ft) msl, or 19 m (60 ft) below maximum pool during 1972. On 15 June 1973, maximum pool was reached for the first time and was maintained until 3 July when drawdown began because of the need for power generation.

Minimum pool elevation was reached on 17 April 1974, when it began filling again reaching maximum pool on 21 July 1974. Flooding in January, 1974 increased inflow and associated turbidity changed the water quality significantly (Falter 1976).

In 1975, minimum pool was reached on 11 April and filling continued through May and June until maximum elevation was achieved on 26 June. Drawdown began

in September and continued through the fall of 1975.

In 1976, minimum pool 440 m (1,445 ft) was reached on 29 March after winter drawdown. Filling continued through the spring until full pool elevation was achieved on 11 July. Due to the drought conditions in the fall, pool evacuation was somewhat reduced in 1976.

TECHNIQUES USED

During 1976, project personnel monitored anglers fishing on Dworshak Reservoir from 4 January to 30 September. We divided the census period into 2-week intervals and interviewed anglers on all weekend days and 4 weekdays per interval. During the spring fishery (4 January to 23 May) weekend census was reduced to 2 days per interval. Four counts at least 2 hours apart were made on each census day. Boat trailers, shore anglers and other recreationists were enumerated. Census days and times of counts were randomly selected. Except for some limited work at Dent, all interviews were conducted at Big Eddy boat ramp. A complete description of reservoir access appears in the previous report (Pettit 1976).

We attempted to contact anglers at the completion of their trips. Car top boats and empty slips at the marina were included in the counts of boat trailers. Between counts, we interviewed anglers to assess: the number of anglers per party, number of anglers per boat, residence of fishermen, total hours fished and catch composition.

Estimates of effort in angler hours are the products of the mean number of anglers per count, times the number of daylight hours, times the number of days (weekend or weekdays) in each interval. The estimated number of boat anglers was derived from boat trailer counts times the mean number of anglers per boat.

Harvest estimates were calculated from the catch rates of each species (or planting size) and the estimated effort in each interval.

The estimates of effort and harvest for anglers fishing at, or launching from, Big Eddy boat ramp were expanded to encompass the entire reservoir. Use at Big Eddy was considered to be proportional to total reservoir use and the expansion factor was calculated from aerial flights.

Angler effort in man-days is the estimated effort in hours divided by the annual mean length of an angler trip for boat and shore anglers.

The average number of daylight hours used to calculated estimated fishing effort was arrived at by using the sunrise and sunset tables of the Nautical Almanac Office, U. S. Naval Observatory. The daily sunrise and sunset values were plotted graphically against dates, and in each 2-week interval, the mid-point values were used to calculate daylight hours.

Aerial Flights

We divided the reservoir into three areas: Area I, from the dam up to Dent Bridge, Area II, from Dent to Grandad Bridge; and Area III, above Grandad Bridge. Each area was segregated into two broad habitat types: reservoir

proper and major arms and bays (Fig. 1).

We flew the reservoir 16 times in a fixed-wing Cessna 172 to assess the distribution of boats on the reservoir and the number of vehicles and boat trailers using the various access sites other than Big Eddy. Each reservoir flight was simultaneous with census effort at Big Eddy.

An aerial expansion factor was derived from aerial counts where the number of boats counted from the aircraft was divided by the number of boat trailers counted at Big Eddy. When no flights were made, the value of 1.0 was used in the total recreational estimator.

Recreational Use

Concurrently with creel census efforts, we counted other recreational users in the same manner as fishermen. Only water-oriented recreational users, such as campers, swimmers, picnickers, hunters, water skiers, and sightseers near and on the water were enumerated.

Estimates of recreational use originated at Big Eddy boat ramp were expanded to the entire reservoir by considering the use at Big Eddy to be proportional to the total. The expansion factor was calculated from aerial flights, the same as for angler use.

During the 1976 census period the method of estimating total recreational use (fishing or boating) was modified to more accurately partition boating activities from fishing estimates. Basically the change involved changing the interview forms to record the hours spent boating or fishing for each party. The old form only required an estimate of fishing hours.

Nets

Monofilament experimental and vertical gill nets were set in the reservoir to sample fish populations. The experimental nets are described by Ball and Cannon (1973). Vertical nets are 30.5 m (100 ft) deep and 1.8 m (6 ft) wide hung on aluminum rollers constructed from 10.2 cm (4 in) irrigation pipe. Aluminum conduit spreaders are attached at 6 m (20 ft) intervals. Each net is a single mesh size and six nets make up each set. Mesh sizes are: 2.5 cm (1 in), 3.8 cm (1.5 in), 5.1 cm (2 in), 6.4 cm (2.5 in), 7.6 cm (3 in) and 10.2 cm (4 in) (stretch measure). Vertical nets were set individually but usually in close proximity to each other, in water 30.5 m (100 ft) deep so they fished in open water.

As in previous years, we set vertical nets in three general locations: the confluence of Elk Creek arm; near Little Weitas Creek and near the Little North Fork arm (Fig. 1).

Horizontal experimental nets were rigged with floats to fish just under the surface in addition to on the bottom. In order to capture larger smallmouth in their preferred habitat next to the shore line, the horizontal nets were set with their larger mesh sizes closest to the shore in 1976.

Fish caught in nets were measured in total length and stomachs were

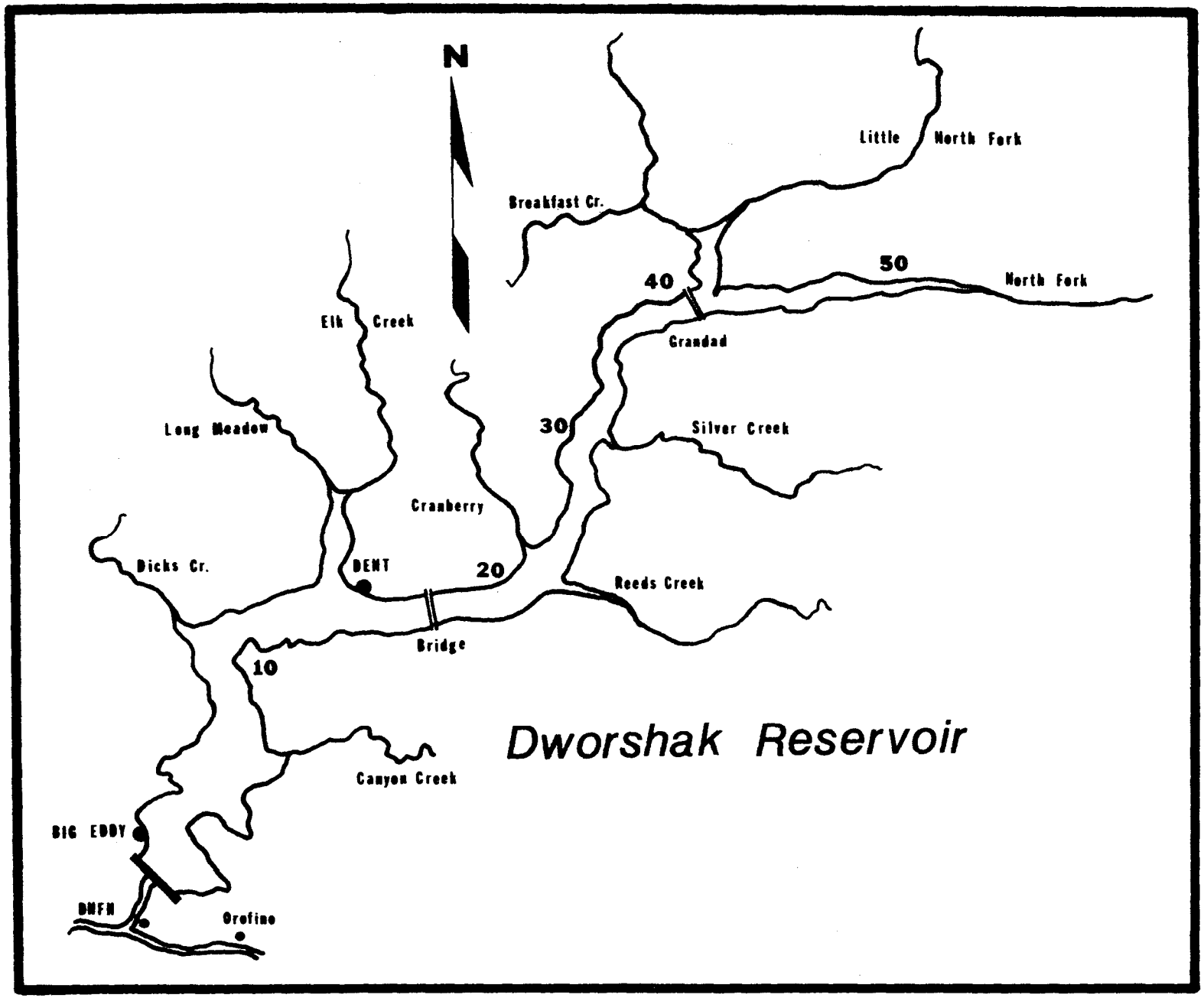

Figure 1. Dworshak Reservoir and major tributaries, North Fork of the Clearwater River, Idaho. Numerals indicate river miles above Dworshak Dam.

collected for food analysis. Food organisms were grouped to order and the frequency of occurrence and the mean number of organisms per fish recorded.

Fish Stocking

All fish released into Dworshak Reservoir in 1976 were reared at Dworshak National Fish Hatchery. In addition, 50,000 smallmouth bass fry were planted on 3 June, which were acquired from Neosle National Fish Hatchery, Missouri. Catchable rainbow trout were released from February to September. From 10 February to 21 September, 79,200 catchable rainbows were planted. Approximately 1,326,000 kokanee were released into the reservoir as fry in 1976. No adult steelhead were released during 1976.

Fish Identification

In addition to differentiation by species, we attempted to separate the rainbow caught by anglers and in gill nets into categories based on their origin or size when they were planted. Resident rainbow and juvenile steelhead were present in the drainage prior to inundation.

Juvenile steelhead could usually be separated from other rainbow by their "smolt" appearance (i.e., silvery coloration and slim body condition). Very few juvenile steelhead were present in the anglers' creels or gill nets in 1974 and 1975.

Rainbow planted as fingerling in 1972 were distinguishable by adipose clips. In 1973, rainbow planted as fingerling were not marked. We marked 22,400 rainbow fingerlings with adipose clips in 1974. In 1975, 21,000 rainbow fingerling were adipose clipped.

Catchable rainbow trout were marked with fluorescent pigment in 1976. Project personnel marked approximately 20,000 catchables one week prior to planting 2 June 1976.

Unmarked rainbow trout are, therefore, defined as unmarked fingerling plants, fry plants or wild rainbow.

Any smallmouth bass captured in gill nets or collected from anglers' creels were aged by the scale method for identification purposes and growth determinations.

FINDINGS

Recreational Use

During the 9-month census period on Dworshak Reservoir in 1976, anglers spent an estimated 126,750 hours fishing. This represents 33% increase over the previous 12-month census in 1975 (Table 1). We estimated that boat anglers fished an estimated 106,580 hours (84%) while shore fishermen spent only 20,170 hours (16%) in 1976. As in 1975, unusually poor weather conditions most likely limited recreational use during the summer.

Table 1. The estimated hours of recreational use on Dworshak Reservoir, 1972-1976.

	1972[a]	1973[b]	1974[c]	1975[d]	1976[e]
Angler effort	19,172	187,502	118,384	85,248	126,747
Shore angler	9,137	16,816	15,025	11,297	20,169
Boat angler	10,035	170,686	103,359	73,951	106,573
Other recreational use	63,769	148,274	92,326	75,625	133,181
Shore activities					12,440
Boat activities					120,741
Total recreational use	82,941	335,776	210,710	160,873	259,928

[a]Census period: 27 May to 15 September
[b]Census period: 28 April to 30 November
[c]Census period: 30 December 1973 to 3 November 1974
[d]Census period: 5 January 1975. to 3 January 1976
[e]Census period: 4 January 1976 to 31 August 1976

For the first time, we attempted to partition non-fishing recreational use into shore activities and boating use. We estimated that other recreationists spent 133,180 hours engaged in non-fishing activities (Table 1). Pleasure boating, water skiing and picnicking were the chief activities during 1976. Shore-based activities accounted for 9% (12,440 hours) of the non-fishing re-recational use while boating activities accounted for 120,740 hours.

Total recreational use during the 1976 census period was estimated at 259,930 hours, the second largest effort measured during the 5-year post-impoundment investigation.

The distribution of boats on Dworshak Reservoir during the census period (23 May to 31 August) in 1976 appears in Table 2, The reservoir areas that boats utilize has varied little during the 5-year period. As in the previous investigations, Area-1 (below Dent Bridge) received the most use by boaters (76%). The distribution of boat related recreational activities reflects the location of access sites for boat launching and fish stocking.

The origin of recreationists traveling to and using Dworshak Reservoir has changed during the 5-year investigation (Pettit 1976). In 1976, 89% of the recreationists interviewed were Idaho residents. Nonresident activities decreased somewhat in 1976 (Table 3) and accounted for only 11% of the use during the census period. Most nonresidents continue to be from the State of Washington.

Angler Effort and Harvest

During the 1976 census period, 4 January to 31 August, fishermen spent

Table 2. The distribution of boats on Dworshak Reservoir as assessed by aerial survey, 1972-1976, by percent of total count.

Area	Percent of use				
	1972	1973	1974	1975	1976
Area I (Below Dent Bridge)	72.7	83.8	78.9	78.8	76.3
Area II (Dent Bridge to Grandad)	17.6	13.2	16.7	15.7	15.9
Area III (Above Grandad Bridge)	9.7	3.0	4.4	5.5	7.8

Table 3. The percentage of resident and nonresident anglers, Dworshak Reservoir, 1972-1976.

	1972	1973	1974	1975	1976
Resident anglers					
Less than 32 km (20 mi)[a]	58.9	25.6	31.1	32.4	38.3
32-64 km (20-40 mi)	31.3	58.2	49.8	49.0	47.0
Greater than 64 km (40 mi)	2.9	3.8	5.2	4.2	3.9
Total	93.1	87.5	86.1	85.6	89.2
Nonresident anglers					
Washington	4.1	9.2	10.4	8.4	5.7
Other states	2.8	3.5	3.5	6.0	5..1
Total	6.9	12.5	13.9	14.4	10.8

[a]Distance from Big Eddy launch

an estimated 126,750 hours to catch an estimated 66,440 fish (Table 4). We interviewed a total of 3,187 anglers; 2,067 boat anglers and 1,120 shore anglers.

Boat anglers spent an estimated 106,578 hours to catch 55,040 fish for an average catch rate of 0.61 fish per hour (Table 4). Boaters accounted for 84% of the total fishing effort and approximately 83% of the estimated catch in 1976. Hatchery rainbow trout made up approximately 52% of the catch; unmarked rainbow trout 6.6%, 1976 rainbow catchables 7.2%; kokanee 26.3%, smallmouth bass 3.8%; cutthroat trout 2.5% and 0.3% Dolly Varden (Table 5).

Shore anglers spent an estimated 20,170 hours to catch 11,400 fish for an average catch rate of 0.59 fish per hour (Table 4). Shore anglers accounted for only 16% and 17% of the total effort and catch, respectively. Hatchery rainbow trout accounted for approximately 81% of the catch; unmarked rainbows 10.8%; 1976 hatchery catchables 2.6%; kokanee 1.1%; smallmouth bass 0.81% and cutthroat trout 1.3% of the catch (Table 6).

The best catch rates occurred during the first 3 months for both boat and shore anglers (Table 7). The catch rates for boat fishermen varied between 0.23 and 1.06 fish per hour for the 17 intervals during the census period. Shore anglers averaged between 1.6 and 0.34 fish per hour.

Fish Stocking

Except for smallmouth bass fry, all fish planted in Dworshak Reservoir and its tributary arms (during 1976) were reared at Dworshak Hatchery (Table 8). Approximately 1.3 million kokanee fry were released near the mouth of Elk Creek on 3 May 1976. These fish were obtained from Lake Whatcom in Washington and were of the late spawning variety. As in 1975, the Elk Creek site was chosen to hopefully develop a spawning population in the tributary. The U. S. Fish and Wildlife Service has constructed a permanent egg-taking station on Elk Creek.

On 3 June, approximately 50,000 smallmouth bass fry were released by Idaho Fish and Game personnel. Fry plants occurred at numerous bays and tributary arms below the mouth of Elk Creek on the lower third of the reservoir.

On 18 February, Dworshak Hatchery personnel planted approximately 18,500 rainbow trout fingerlings at Big Eddy boat launch. In June, an additional 615,000 rainbow trout fry were planted. Approximately 455,000 fry were released between Dick's Creek and Silver Creek, and another 160,000 at the Canyon Creek arm.

Catchable rainbow trout were planted throughout the year between 10 February and 21 September. In most cases, the catchables were released from Big Eddy (Table 8). A total of 79,200 catchables were planted in 1976. In order to determine the percent return to the anglers' creel for a particular group of catchables, we began a fluorescent pigment marking program to identify fish from an individual stocking date. Ideally, we had hoped to mark two groups: those released in early June, and a later group released in mid-September, but were unable to mark the September group. On 2 June, approximately 19,700 catchable rainbows marked with orange pigment were planted

Table 4. Angler interviews, catch rates and harvest estimates for Dworshak Reservoir, 1972-1976.

	1972	1973	1974	1975	1976
Number interviewed	1,614	6,621	1,954	2,269	3,187
Boat	744	5.217	989	1,586	2,067
Shore	870	1,404	965	684	1,120
Total effort[a] (hrs)	19,486	187,502	118,384	85,248	126,747
Boat	10,349	170,359	103,359	73,951	106,578
Shore	9,137	16,816	15,025	11,297	20,169
Catch rate (fish/hr)					
Boat	1.5	1.49	.59	.82	.61
Shore	1.2	1.19	1.67	.75	.59
Estimated harvest					
Boat	12,727	246,687	60,092	68,523	55,037
Shore	10,035	18,040	25,237	8,418	11,400
Total	22,762	264,727	85,329	78,941	66,437

Table 5. Estimated effort and harvest by species for boat anglers, Dworshak Reservoir, 1976

Two-week interval beginning	Interval No.	Estimated hours fished	HRBC	HRBF Ad Clip	URB	F1[*1] HRBC	KOK	SMB	CT	DV	WF	BBH	OT	Total
4 Jan	1	285	274		31									305
18 Jan	2	1,157	833		162		23		23					1,041
1 Feb	3	1,479	843	6	59		15		15					938
15 Feb	4	2,082	1,083	4	62		42		21					1,212
29 Feb	5	2,251	990		113		113		45					1,261
14 Mar	6	4,915	2,605		295		1,327		246					4,473
28 Mar	7	10,050	3,317	8	50		1,307	10	201					4,893
11 Apr	8	7,357	4,341	15	110		294	15	132					4,907
25 Apr	9	-	-	-	-	-	-	-	-	-	-	-	-	-
9 May	10	-	-	-	-	-	-	-	-	-	-	-	-	-
23 May	11	9,361	2,092	94	374		374	168	281	75	9	19		4,296
6 June	12	11,838	4,498		947	296	355	234	118	36	36	234		6,754
20 June	13	14,497	1,739		435	869	1,739	72	145	43	13	13		5,068
4 July	14	12,791	1,918		384	768	2,430	384	6			128		6,018
18 July	15	7,854	1,099		236	785	1,964	526	55					4,665
1 Aug	16	9,930	1,787		199	894	3,574	596	59					7,109
15 Aug	17	10,731	464	19	186	371	927	93				39		2,097
Totals		106,578	28,693	146	3,643	3,983	14,484	2,098	1,34	154	58	431		55,037
Percent			52.1	.3	6.6	7.2	26.3	3.8	2.5	.3	.1	.8		100.0

[*1]Not planted until June, 1976 (Florest Pigment)

HRBC = Hatchery rainbow planted at catchable size
HRBF = Hatchery rainbow identifiable as 1975 or 1972 fingerling plants
KOK = Kokanee
URB = Unmarked rainbow (wild fish and unidentifiable plants)
SMB = Smallmouth bass
CT = Cutthroat
DV = Dolly Varden
WF = Mountain whitefish
BBH = Brown bullhead
OT = Others (squawfish, suckers)

Table 6. Estimated effort and harvest by species for shore anglers, Dworshak Reservoir, 1976

Two-week interval beginning:	Interval No.	Estimated hours fished	HRBC	(HRBF) Ad Clip	URB	F1*1 HRB	KOK	SMB	CT	DV	WF	BBH	OT	Total
4 Jan	1	70	4		7									11
18 Jan	2	914	713	101	238				18					1,070
1 Feb	3	439	162	2	53				2					219
15 Feb	4	1,246	935	12	87				7					1,041
29 Feb	5	1,723	465	12	86		52		12					627
14 Mar	6	1,742	873	42	165				7					1,087
28 Mar	7	2,463	1,502				35		7					1,544
11 Apr	8	1,631	1,240		98		33		33					1,404
25 Apr	9	-	-	-	-	-	-	-	-	-	-	-	-	-
9 May	10	-	-	-	-	-	-	-	-	-	-	-	-	-
23 May	11	1,360	680	27	218			27	41			27		1,020
6 June	12	1,788	787		125	13		18	5					948
20 June	13	1,117	190	5	112	89		11				11		418
4 July	14	551	204		28	55			6		3	3		299
18 July	15	1,109	455	6	6	67		-	3					537
1 Aug	16	1,195	610			48		36	5					699
15 Aug	17	1,374	440		8	27					-			475
Totals		20,169	9,260	207	1,231	299	120	92	146		3	41		11,399
Percent			81.2	1.8	10.8	2.6	1.1	.81	1.3		.03	.36		100.0

*1Not planted until 1976

HRBC = Hatchery rainbow planted at catchable size
HRBF = Hatchery rainbow identifiable as 1975 or 1972 fingerling plants
KOK = Kokanee
URB = Unmarked rainbow (wild fish & unidentifiable plants
SMB = Smallmouth bass
CT = Cutthroat
DV = Dolly Varden
WF = Mountain whitefish
BBH = Brown bullhead
OT = Others (squawfish, suckers)

Table 7. Number of anglers interviewed and catch rates of anglers fishing at or launching from Big Eddy boat ramp, Dworshak Reservoir, 1976

Two-week interval beginning:	Boat anglers			Shore anglers		
	No. anglers interviewed	Total hours	Fish/hr	No. anglers interviewed	Total hours	Fish/hr
4 Jan	16	67	1.06	9	21	.15
18 Jan	44	205	.90	29	655	1.16
1 Feb	167	742	.64	67	190	.49
15 Feb	95	432	.58	53	160.5	.84
29 Feb	107	509.5	.57	90	252.5	.37
14 Mar	78	345.5	.91	70	241.5	.61
28 Mar	210	1,147	.49	111	357	.62
11 Apr	77	403	.67	55	145.5	.87
25 Apr	-	-	-	-	-	-
9 May	-	-		-		-
23 May	196	827	.46	68	116	.75
6 June	151	680	.60	105	289	.55
20 June	327	1,174	.36	110	246	.40
4 July	216	737	.47	71	155	.56
18 July	153	596	.55	118	350	.48
1 Aug	129	501	.72	105	262	.61
15 Aug*	101	450.5	.23	59	167	.34
Total	2,067	8,816.5		1,120	30,185	
Mean fish/hour (weighted by hours)			.61			.59

*Last interval - 17 days in length to August 31, 1976

Table 8. Fish planted in Dworshak Reservoir by Dworshak National Fish Hatchery, 1976

Date	Number	Lbs.	Location
Kokanee			
3 May	1,326,000 (L)	640	Mouth of Elk Creek
Smallmouth Bass			
3 June	50,000	3.2	Lower tributaries
Rainbow Fingerlings			
18 February	18,500	5,318	Big Eddy
Rainbow Fry			
15 June	455,000	1,746	Dick's Creek to Silver Creek
25 June	160,000	400	Canyon Creek
	615,006	2 ,146	
Rainbow Catchables			
10 February	1,000	150	Big Eddy
15 March	18,649	6,505	Big Eddy
5 April	19,824	5,664	Big Eddy
2 June	19,768 (P)	5,901	Big Eddy
30 August	8,300	6,474	Dent Acres and Big Eddy
8 September	7,288	5,467	Big Eddy
21 September	4,378	4,130	Big Eddy
	79,207	34,291	

(L) Late spawners
(P) Fluorescent pigment marking

at Big Eddy. Census clerks began examining angler catches with a portable ultraviolet light immediately after the release for the remainder of the census season. We found that in many cases the pigment was visable with the naked eye during the 3-month census period. These individuals most likely received an excessive number of pigment granules during the spraying process. By placing fish in a semi-dark enclosure (cardboard box painted black) census clerks were able to quickly examine rainbow trout from anglers' creels. I feel that fluorescent pigment granules provide a very satisfactory and economic marking technique which managers may wish to use when large numbers of fish are to be marked.

Food Habits

The food habits of the different fish species in Dworshak Reservoir have been closely correlated to the fluctuation of water level, the time of the year, the distribution, size and race of fish (Pettit 1976). Of these, the water fluctuation and related water quality parameters probably played the most significant role in food utilization for all species in the reservoir. During a year's time, the water level may fluctuate 48 m (155 ft). This fluctuation results in loss of most littoral aquatic invertebrates and prevents successful recolonization of any new species.

In 1976, the number of fish stomachs analyzed was somewhat reduced from the previous 4 years. Poor gill net catches and mechanical problems with the project boat plagued researchers throughout the season. We sampled the contents of only 29 rainbow trout, 30 kokanee, 9 cutthroat, 15 whitefish, 15 Dolly Varden, and 6 smallmouth bass.

Rainbow trout relied chiefly on aquatic insects and other fish species in 1976 (Table 9). Adult dipterans and nymphs of plecopteran species occurred with the most frequency. Their occurrance in rainbow stomachs was also significantly greater than during the previous summer. Adult tricopterans were found in 12% of the stomachs sampled. The remains of fish were found in 40% of the rainbow trout stomach samples and supports our theory that large trout have converted to a piscivorous diet (Pettit 1976). As in all previous investigations, significant amounts of debris were found in rainbow stomachs.

Of the 30 kokanee stomachs analyzed, 57% were empty when examined. The food items found with the highest frequency (23%) were, suprisingly, larval dipteran species. More commonly preferred zooplankton species were found in significantly lower numbers than in the previous 4 years. We found only 8% of the kokanee stomachs containing copepods and cladocerans. Other taxa of aquatic insects were found including emphemeropterans 15%, and plecopterans 15%.

Cutthroat trout stomach samples indicated that adult dipterans, adult and larval plecopterans, occurred in 33% of the fish sampled. Adult tri-copteran species occurred in 22% of the stomachs sampled. Cutthroat also relied heavily on terrestrial insects where members of the family hymenoptera and coleoptera were found in 44% of the stomachs sampled. We also found the remains of fish in 22% of the samples.

Mountain whitefish utilized larval forms of dipteran species (29%) and adult forms were found in 14% of the stomachs. We found 57% of the whitefish

Table 9. Stomach contents of fish collected in gill nets, Dworshak Reservoir, 1976

	Rainbow		Kokanee		Cutthroat		Whitefish		Dolly Varden		Smallmouth bass	
	F/0*	Mean[1]	F/0	Mean	F/0	Mean	F/0	Mean	F/0	Mean	F/0	Mean
Aquatic												
Diptera												
Adult	28	19			33		14%	3				
Larvae & pupae	8	2	23	50	11		29%	6				
Ephemeroptera												
Adult	0	0	8	1								
Nymphs	4	12	15	128	11							
P1ecoptera												
Adult	8	2			33							
Nymphs	16	24	15	15	33							
Tricoptera												
Adult	12	2			22							
Nymphs	0	0										
Cladocera	0	0	8	100+								
Copepoda	0	0	8	80								
Terrestrial												
Hymenoptera	16	20	8	1	44							
Hemiptera	4	3			22				8	1		
Coleoptera	16	5			44							
Neuoptera	0	0										
Raphidiodea	0	0										
Isoptera	0	0										
Lepidoptera	0	0										
Unidentifiable												
Adult insects	12	0	8		11		14%	3				
Miscellaneous												
Arachinida												
Fish	40	2			22				69	2	50%	3
Algae	16											
Annelida												
Crustaceans												
Debris	24		8				14%					
Number of stomachs with food items	25		13		9		7		13		6	
Number of empty stomachs	4		17		0		8		2			

*Frequency of occurrence (%)

[1]Mean number per fish that had each taxa present

stomachs to be empty when examined.

Dolly Varden stomachs samples indicated that 70% were feeding on other fish species compared to 100% occurrence in 1975.

Smallmouth bass samples had fish in 50% of the stomachs, and 25% had crustaceans present.

Fish Abundance, Distribution and Dispersal

Project gill nets captured a total of 953 fish in 1976; 507 in vertical nets and 446 in horizontal nets (Tables 10 and 11). As in 1975, mechanical difficulties with the research vessel reduced gill netting efforts in 1976. The complete failure of the drive shaft on the boat prevented any sampling during the fall months.

Nongame species (88%) accounted for the majority of the experimental catch: 75% redside shiners; 8% bridgelip, or large scale suckers; 6% northern squawfish and a few chiselmouth. Rainbow trout made up 4% of the catch, Dolly Varden 2%, kokanee 3% and smallmouth bass 2%. Cutthroat made up less than 1% of the total catch.

As in the previous 3 years, the bulk of the rainbow trout were captured in Area I. This is expected since the bulk of the stocking occurs in the lower third of the reservoir.

We captured 28 kokanee during 1976 compared to 20 individuals in 1975. Apparently more time should be spent specifically seeking out areas where kokanee are more abundant and more readily captured with vertical nets. In an attempt to sample more kokanee, we moved the sample location from the mouth of Elk Creek to the Freeman Creek area during July and August netting trips. We also added extra rope to allow the vertical nets to fish at a depth of 41 m (135 ft) rather than 30 m (100 ft). Only a single individual was captured from a depth greater than the original length. Most of the kokanee captured during July and August were captured between the 10 m to 22m (35 to 75 ft) levels.

We increased our success in capturing adult smallmouth bass in the horizontal nets by reversing the manner in which we deployed the nets. Previous to the August trip, we had been setting horizontal nets with the smaller mesh sizes closest to the shore line. By placing the larger mesh closest to shore, we increased the number of adult bass captured by 86% (Table 10). Only two individuals were captured above the Dent Bridge in 1976.

Hatchery Rainbow Trout

The number of catchable rainbow trout planted in Dworshak Reservoir averaged 175,560 annually except for 1974, when only 16,700 catchables were released (Table 12). All catchable plants originated from Dworshak Hatchery and were released by hatchery personnel. An estimated 244,700 of the 718,960 catchables planted during the 5-year investigation have been harvested. This represents approximately a 31% return to the anglers' creel during the 5-year period. No external marks were used to identify catchables planted in

Table 10. Species composition of fish caught in experimental horizontal gill nets in Dworshak Reservoir, 1976

Net No.	Location	Date lift	Hrs.	HRBC	URB	HRBF	CT	DV	WF	RSS	SQ	SU	CM	SMB	Total
1-F	Elk Cr. Arm	5-4	15.5	1				3		5	7				16
2-S	Elk Cr. Arm	5-4	17.0		1			1	3	31	2	10		1	49
3-F	Silver Cr. Confi.	5-5	16.0		1		2	1		12	6	1			23
4-S	Silver Cr. Confl.	5-5	16.5							15	1	1			17
5-F	Breakfast Cr. Confi.	5-6	17.5	1			1			6	1				9
6-S	Breakfast Cr. Confi.	5-6	18.5						1	3		4			8
7-F	Little North Fk Arm	6-15	15.0	1						4	7		1		13
8-S	Little North Fk Arm	6-15	15.0									2			2
9-F	Boathouse Cr. Confi.	6-16	14.0	4	1					3	5		1		14
10-S	Boathouse Cr. Confi.	6-16	14.5		1				1	43	5	8	1	2	61
11-S	Elk Cr. Arm	6-17	15.0	2						27	2	17	1	1	50
12-F	Elk Cr. Arm	6-17	15.5	1						5					6
13-F	Main Reservoir-RM 45.9	7-17	14.5									1			1
14-S	Main Reservoir-RM 45.9	7-17	14.0						1	2					3
15-F	Follet Cr. Confi.	7-18	16.0							15		2			17
16-S	Follet Cr. Confi.	7-18	16.0		1			2		35		2			40
17-F	Freeman Cr. Confl.	7-19	14.0							3					3
18-S	Freeman Cr. Confi.	7-19	14.0							3		1			4
*19-F	Freeman Cr-Little Bay	7-30	14.5							1				2	3
*20-S	Freeman Cr-Little Bay	7-30	14.0	3				1	1			2		2	9
21-F	Silver Cr Confi.	8-18	14.5							5	1				6
22-S	Silver Cr Confi.	8-18	14.5	4								3			7
23-F	Main Reservoir-RM 47.3	8-19	13.0							1	2	4			7
24-S	Main Reservoir-RM 47.3	8-19	13.0	1			1			3	3	3			11
25-F	Freeman Cr.-Little Bay	8-20	12.0	2						9	2				13
26-S	Freeman Cr.-Little Bay	8-20	12.0	1		6				19	4	10		14	54
	Total		386	21	5	6	4	8	7	250	48	71	4	22	446
	Percent			4.7	1.1	1.3	.9	1.8	1.5	56.0	10.8	15.0	.9	4.9	

*Reflects addition of 35' extension on 12" & 2" nets

HRBU = Hatchery rainbow catchable
HRBF = Hatchery rainbow catchable (fluorescent)
URB = Unmarked rainbow
CT = Cutthroat
DV = Dolly Varden
WF = Mountain whitefish
RSS = Bedside shiner
SQ = Squawfish
SU - Sucker
CM = Chiselmouth
SMB = Smallmouth bass

Table 11. Species composition of fish caught in overnight vertical nets and associated water temperatures, Elk Creek confluence, Freeman Creek, Dworshak Reservoir, 1976

Depth in feet	4-6 May						15-17 June						17-19 July						
	Temp.(C)	RSS	SQ	HRBC	CT	SU	Temp.(C)	RSS	SQ	DV	HRBC	KOK	Temp.(C)	RSS	WF	KOK	URB	DV	SU
0-10	10.0-9.5	25	3	1	1		17.0-16.0	122	2		1		23.0-21.5	173					
10-20	9.5-8.5	12					16.0-12.5						21.5-15.0	25			1		1
20-30	8.5-7.0						12.5-10.0					1	15.0-13.5	24					
30-40	7.0-7.0	1					10.0- 9.0			1			13.5-12.0						
40-50	7.0-6.5	1					9.0- 9.0						12.0-10.5	1		2			
50-60	6.5-6.0						9.0- 8.5						10.5-10.0						
60-70	6.0						8.5						10.0- 9.5						
70-80	6.0						8.5						9.5- 9.0		1				
80-90	6.0	1					8.5						9.0- 8.5						
90-100	6.0					1	8.5- 8.0						8.5					1	
Totals		40	3	1	1	1		122	2	1	1	1		223	1	2	1	1	1

	30 July (Freeman Creek)		18-20 August (Freeman Creek)			
	Temp. (C)	KOK	Temp.(C)	RSS	KOK	SQ
0-10	23.0		21.0	61		
10-20	23.0-18.5		21.0	15		
20-30	18.5-14.5		21.0-16.0			
35-45	14.5-13.0	1	16.0-13.5		3	
45-55	13.0-11.5	4	13.5-11.5		3	1
55-65	11.5-10.5	3	11.5-10.5		2	
65-75	10.5-10.0	1	10.5-10.0		9	
75-85	10.0- 9.5		10.0- 9.5		1	
85-95	9.5- 9.0		9.5-9.0			
*95-105	9.0- 8.5		9.0- 8.5		1	
105-115	8.5		8.5			
115-125	8.5- 8.0		8.5			
125-135	8.0- 7.5		8.5			
Totals		9		76	19	1

*Reflects addition of 35' extension on 1½" & 2" nets

KOK = Kokanee RSS = Redside shiner SQ = Squawfish
RB = Rainbow trout CT = Cutthroat trout SU = Sucker

successive years, and therefore, no annual return percent is available. Evidence exists which indicates that in favorable years, significant numbers of catchable trout overwinter and contribute to the harvest the following year. In 1974, only 16,700 rainbow catchables were planted, yet anglers harvested an estimated 29,300 fish (Table 12).

Table 12. The annual stocking rate and estimated harvest of hatchery catchable rainbow trout from Dworshak Reservoir, 1972-1976.

Year	HRBT planted	HRBT harvested
1972	269,826	26,400
1973	118,526	131,920
1974	16,702	29,292
1975	234,695	19,174
1976	79,207	37,953

As previously mentioned, the 1976 catchables included a group of marked fish to aid in identification from the angler's creel. Of the 19,770 fish marked with fluorescent pigment granules, we estimated that anglers harvested 4,282 by the end of the census period. This represents a 21% return to the creel during the 3-month period after release on 3 June. We also collected 6 fluorescent marked rainbows from the gill nets set at Freeman Creek during August.

Growth rates for rainbows planted as catchable-size fish were not measured in 1976. Growth rate and length frequency information is available in previous annual reports.

Fingerling Rainbow Trout

The fingerling program has produced excellent quality rainbows for the reservoir fishery. During the 5-year investigation, Dworshak Hatchery planted 4,519,836 rainbow fingerlings into the reservoir (Table 13). Anglers have harvested an estimated 85,425 rainbows planted as fingerlings during the 5-year study. This represents only 2% of the total planted but has accounted for approximately 52% of the annual harvest in 1974 and 1975.

Perhaps more significant has been the excellent condition of rainbow planted as fingerling once they are recruited into the fishery. Ball and Cannon (1974) reported that rainbows planted as fingerling in 1972 averaged 273 mm (10.7 in) the following spring. Rainbows from the 1972 fingerling release (adipose clip) continue to enter the catch and have reached trophy size. An individual fish was captured during the winter of 1975 that weighed 4.8 kg (10.5 lb) and numerous adipose-clipped fish were captured in the 2.3 to 3.2 kg (5 to 7 lb) range.

Table 13. The annual number of rainbow trout planted as fingerlings and the estimated harvest from Dworshak Reservoir, 1972-1976.

Year	FRBT planted	FRBT harvest
1972	773,630	2,771
1973	2,324,452	56,210
1974	750,228	25,036
1975	653,026	1,055
1976	18,500	353

It appears that rainbows planted as fingerling have been able to adjust well to the available reservoir food sources and more importantly, converted to a piscivorous diet capable of producing trophy-size fish. Fingerling plants did not suffer from the same loss of condition during 1974 that catchable trout did and this may reflect their better adaptability and fish oriented diet.

The identification of rainbow trout planted as fingerling has become more difficult since natural reproduction and recruitment from tributary spawning rainbows are occurring. Attempts should be made to mark an entire fingerling release in the near future as was done in 1972 when over 200,000 fish were fin clipped. This would determine accurate return and growth rates as well as help in identifying fingerling plants from other wild or unmarked rainbows.

Kokanee

The harvest of kokanee from Dworshak Reservoir began in 1973. These fish were planted in Breakfast Creek, a tributary of the Little North Fork, in June 1972. Approximately 1,012,745 fingerling kokanee were released. A few precocial males were collected in October of 1972. All fish planted in 1972 were early spawning kokanee.

Anglers harvested an estimated 51,350 kokanee during the census period in 1973 (Tablel4). Maturation of adult fish was investigated in 1973 and results appear in the annual report. Kokanee began moving up to the mouth of tributaries in late July and early August. Spawners became more numerous and continued to accumulate at the mouths of Breakfast Creek and Little North Fork. Large numbers of spawners also migrated into the main North Fork and were observed during September as far as 121 km (75 mi) upstream from the reservoir (Ball and Pettit 1974). The sex ratio was imbalanced in favor of males among spawners in 1973 and we estimated that between 70 and 90% of the males matured in 1973 as age 2 fish.

Anglers harvested 49% fewer 3-year-old kokanee during 1974 for a total harvest of 25,320. We estimated that approximately 8.0% of the total kokanee planted in Breakfast Creek in 1972 were harvested during 1973 and 1974. All

Table 14. The annual number of kokanee planted in Dworshak Reservoir tributaries and the estimated harvest from the reservoir, 1972-1976.

Year	Kokanee planted	Kokanee harvest
1972	1,012,745	None
1973	591,192	51,352
1974	217,300	25,320
1975	3,084,873	13,756
1976	1,326,000	14,604

of the kokanee sampled during August and September 1974 were mature fish. Both males and females averaged approximately 330 m (13,0 in) in September collections.

The catch of kokanee continued to decline in 1975 as was expected. Stocking recommendations called for 4 million kokanee to be planted annually and plants in 1973 and 1974 totalled less than 900,000. The stocking program in 1975 improved significantly and over 3 million early spawning fry were released.

The estimated catch of kokanee during the 1976 census period was 14,604. This represented a 6% increase over 1975 and would have been significantly better had the census period continued for the full 12 months. Approximately 1,326,000 early spawning kokanee were planted in 1976.

The winter and spring drawdown may be responsible for significant losses of kokanee each year. This loss was first noted in April 1974 when immature and mature kokanee were observed dying and washed ashore below the dam. Further investigation showed that hundreds of dead and dying fish could be found each day between the mouth of the North Fork and Peck during periods of high spill. We failed to observe any losses during 1975, but high spills in March and April 1976 produced losses which appeared to be greater than those during 1974. Kokanee from three different year classes could be found by hundreds immediately below the Dworshak powerhouse in 1976. Fish kills were only associated with periods of high spill. These losses would be exceedingly difficult to quantify and impossible to prevent as kokanee were probably responding to migratory urges brought on during periods of increased discharge.

The extreme drought condition during the winter and spring of 1977 eliminated the need for spilling. Project personnel were unable to find any kokanee or evidence of losses during the same period when significant mortalities had been observed in previous years. At the same time, no kokanee entered the hatchery via the fish ladder which had been a common phenomena during the periods of increased spring discharge. It now appears that loss through the dam could be significant, especially during years when high spills occur and particular year classes are weak.

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